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A study sought to cause a change in the question-phrasing practices of 40 students enrolled in elementary science methods classes. A method of instruction involving the analysis of videotaped classroom lessons illustrative of four categories (cognitive-memory, convergent, divergent, and evaluative) of poorly phrased and effectively phrased questions was designed and used as the basis of seven periods of instruction designed to cause a significant change from a greater proportion of low level (cognitive memory) questions, contructed by the students for elementary school science lessons, to a greater proportion of high level (divergent) questions. Questions constructed by students on pre- and posttests were evaluated by seven judges. Data analysis included use of the "sign" test and chi square to test the significance of change. Findings led to conclusions that the ability of prospective elementary teachers to construct a greater proportion of effectively phrased questions can be improved by instruction, that they can learn to construct a greater proportion of divergent questions for science, and that a method of instruction employing the analysis of videotaped classroom lessons can be effective for causing such change. (Included are the measurement instruments, criteria for analyzing questions, transcriptions of videotaped lessons, bibliography, discussion of implications, and recommendations.) (JS)

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A DESCRIPTIVE STUDY DETERMINING THE EFFECTS OF A METHOD OF INSTRUCTION DESIGNED TO IMPROVE THE QUESTION-PHRASING PRACTICES OF PROSPECTIVE ELEMENTARY TEACHERS

BY

ROGER THOMAS CUNNINGHAM

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for the Doctor of Education degree
in the School of Education
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1968

Accepted by the faculty of the School of Education, Indiana University, in partial fulfillment of the requirements for the Doctor of Education degree.

James E. Weigand
Director of Thesis

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R.T.C.

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CHAPTER I

INTRODUCTION

Today the more recognized developments in the elementary school science curriculum stress the teaching of science as inquiry. Traditionally, elementary school teachers have been more concerned with the product of science. There has been more concern for rote memory of factual information rather than the modes of inquiry. The inquiry approach does not emphasize the accumulation of knowledge. It is more concerned with the processes by which this knowledge is sought. The emphasis is on the search rather than the product.

Bruner's often quoted phrase, some intellectually honest manner,[1] has significance for learning science and is a very basic premise for considering the teaching and learning of science as inquiry. If science prescribed for learning by a child is to be intellectually honest, it must be science that is recognizable to a scientist as science. If science, then, is defined as an intellectually active process of problem identification, experimenting, data interpretation, hypothesizing and testing; and inquiry can be defined as a method of gathering, processing and testing data, then science can be seen as inquiry. If science to be learned by children is to be intellectually honest, then it must be science as inquiry.[2]

The Educational Policies Commission set the major goal of education as the ability to think, which in turn is defined as the use of the rational powers. These rational powers are identified as recalling and imagining, classifying and generalizing, comparing and evaluating, analyzing and synthesizing, and deducing and inferring.[3] Examination of these rational powers reveals that they are essentially the same as the elements of inquiry. It follows, then, that intellectually honest science, learned and taught as inquiry, provides for developing the rational powers, i.e., the ability to think, thereby contributing to the goal of general education; therefore it should be included in the educational experiences of the child.

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[1] Bruner, Jerome, The Process of Education, p. 33.

[2] Renner, John, "A Case for Inquiry," Science and Children 4:30-34, March, 1967.

The elementary teacher must believe that the development of the child's rational powers and his understanding of how to solve problems are at least as important as the factual information learned in an investigation. It is important to stress, too, that inquiry is one mode of learning. The teacher must also practice inquiry; teaching must be seen as an act of inquiry where the teacher plays an unique and vital role. He must provide the climate and the conditions necessary for inquiry, structure the process, and assist the pupil in evaluating his own experiences.[4] The teacher is a guide and one of his most effective tools is skill in effective questioning.

By nature of its constituents, inquiry is a means for asking and answering questions. The example set by the teacher for questioning can be most important to inquiry activities. Research shows that this approach to teaching not only does a better job of helping children develop the inquiry skills but also helps them comprehend the big ideas of science.[5]

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[3] Educational Policies Commission, The Central Purpose of American Education, p. 12.

[4] Renner, op. cit., pp. 31-32.

Comments by Taba[6] reflect the need for teachers to place more emphasis on the autonomous development of the cognitive skills. Teachers need to learn to do less telling and more asking of questions that stimulate higher levels of thought. Available evidence, that demonstrates a close relationship between the nature of the question asked and the thoughts elicited from the children, illustrates the need to focus on cognitive operations as well as content in questioning procedures by the teacher. A study by Taba, Levine, and Elzey[7] demonstrated a nearly perfect correlation between the level of verbally expressed thoughts by children and those sought by teachers in their questions.

A survey of the literature indicates that much has been written citing the inadequacy elementary teachers have for formulating and using appropriate and effective questions. For example, Moyer[8] found that teachers in his study were unprepared to develop and utilize the questioning process effectively. In a study by Floyd[9] it was found that of the 1,347 questions asked by 40 primary teachers less than 100 were suitable for stimulating reflection. In addition, he found only six per cent of these questions worthy of pursuit. Gagnon[10] found that a significantly large number of questions asked by teachers elicited no more than memory responses. Adams[11] found that 90 per cent of the questions asked called for reproduction of what is in textbooks. There is strong evidence indicating a need to improve the ability of elementary school teachers to phrase effective questions.

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[5] National Society for the Study of Education, Rethinking Science Education, Part I, 1960, 306 pp.

[6] Taba, Hilda, "Implementing Thinking as an Objective in Social Studies," in Effective Thinking in the Social Studies, pp. 25-49.

[7] Taba, Hilda; Levine, Samuel; and Elzey, F. F., Thinking in the Elementary School Children, 207 pp.

[8] Moyer, J. R., An Exploratory Study of Questioning in the Instructional Processes in Selected Elementary Schools, 281 pp.

[9] Floyd, William, An Analysis of the Oral Questioning Activity in Selected Colorado Primary Classrooms.

The investigator, in his nine years of experience observing elementary teachers and evaluating prospective teachers, has found this inability to phrase questions to be a major problem. He has further observed that this inability seriously handicaps the teacher in developing and pursuing science concepts with children. It is this difficulty in phrasing questions which causes the children not to see meaning and purpose in a particular concept and prevents them from reaching higher levels of thinking in their learning. Many teachers are not aware of the levels of concreteness or abstractness of questions which are most suited to a particular learning situation.

There is a definite need to provide prospective teachers with skill in formulating questions. With such an ability, they would gain more insight into the teaching-learning situation, stimulate and support the inquiry process, improve the process itself, and improve the teaching of science at the elementary school level. It also seems apparent that such an ability would give the novice the tool to overcome the long established fear of teaching science. In addition, possession of this ability, should enable the prospective elementary teacher to help children see the most important ideas and to formulate their own questions relevant to the inquiry process. The need for improving the quality of questions and questioning techniques is quite apparent when one considers the importance that has been attached to questioning, the extensive use of questioning, the defects shown by previous studies, the desirability of improved practices in all areas of education, and the arbitrary nature of the information available in the literature on methods.[12]

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[10] Gagnon, L. A., "An Analysis of an Experimental Methodology for Teaching Thinking with Clarifying Values," Dissertation Abstracts 25: 1293A, 1965.

[11] Adams, Thomas, "The Development of a Method for Analysis of Questions Asked by Teachers in Classroom Discussions," Dissertation Abstracts 25:2809-2810, November-December, 1964.

Weigand[13] found that prospective elementary teachers can develop the ability to identify relevant questions asked by children. This evidence suggests that prospective teachers could also develop the ability to identify questions relevant to the inquiry process. From this it would seem that prospective elementary teachers could also develop the ability to formulate questions to carry out the process with children. Because question-asking is so essential to the method of inquiry, teachers should be educated in a manner that will permit them to improve the ability of pupils to raise questions.

It seems quite apparent that the effectiveness of the inquiry approach and the learning and teaching of science as inquiry is heavily dependent upon asking the proper questions. These are questions that call for higher levels of thinking, that encourage children to ask questions, and that stimulate and direct the inquiry process.

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[12] Houston, V. M., "Improving the Quality of Classroom Questions and Questioning," Educational Administration and Supervision 24:17-28, January, 1938.

[13] Weigand, J. E., The Relative Merits of Two Methodologies for Teaching the Analysis of Children's Questions in Elementary School Science, 100 pp.

It is the contention of this study that experience with a technique of phrasing questions is a major factor in identifying the relevancy of questions. This study also contends that prospective elementary school teachers must have experience with a question-phrasing technique to have the ability for eliciting questions and responses from pupils that are essential to the inquiry process. This ability should also enable the prospective teacher to initiate and support the inquiry process with carefully planned and executed questions designed to cause cognitive development at all levels. If these prospective teachers can develop this ability through instruction, then it is apparent that improvements should be made in the present program for elementary science methods.

Statement of the Problem

If, through a method of instruction that employs analysis of video-taped classroom lessons, prospective elementary teachers can show a significant improvement in their ability to phrase a greater number of higher level (divergent) questions and at the same time show a significant decrease in the number of lower level (cognitive memory) questions used for elementary science lessons, then it is possible that these prospective elementary teachers can be more adequately prepared for this aspect of the teaching act.

The investigator in this study seeks some evidence that a method of instruction designed to effect change in the question-phrasing ability of prospective elementary teachers can facilitate the teaching and learning of science as inquiry.

Since no control or comparison groups were used, the study was characterized as a descriptive or exploratory study rather than an experimental one. If the investigator can demonstrate the effectiveness of certain elements of this methodology, then these elements can be described as a method of instruction that could be used in elementary science methods courses. The criteria used to define the method of instruction used in the study have been derived from analysis of 55 classroom science lessons conducted by student teachers who have completed a course in elementary science methods. These criteria have been defined by the investigator, who does not seek to validate the method of instruction or the instruments used in the study. However, he does seek to cause a conscious concern for asking more divergent questions, and to develop an ability to formulate a greater number of divergent questions based on the inquiry process.

Because descriptive research is sometimes depreciated, the investigator feels a need to offer some defense. If very little is known about an act, the way to begin an investigation of it is to observe and analyze the act itself. When observed and analyzed, that act can be categorized into its various components until the factors which are involved in it are understood and clearly described. Unless this takes place it is doubtful that there is any feasibility in making predictions, determining causal factors, or identifying correlations. Therefore, the kind of knowledge available about the act dictates to some extent the kind of study that is appropriate. A descriptive study of a method of instruction can be justified because it is preliminary to experimental investigation of the act itself.

Basic Assumptions

1. The questions written on the pre-test and post-test were considered as indices of the ability of the students, at that time, to write questions according to the established criteria.

2. The prior teaching of the subjects by different instructors did not have a varying effect upon the students' ability to formulate and write appropriately phrased questions.

3. The current instructional practices and other concomitant experiences did not have a varying effect upon the students' ability to formulate and write appropriately phrased questions.

4. The programs for the two groups of students used in the study were not different enough to have a varying effect on their ability to formulate and write appropriately-phrased questions.

5. The experience with the simulation materials prior to methods instruction did not have a varying effect upon the ability of the INSITE students to formulate and write appropriately-phrased questions.

6. The improvement in the ability to formulate and write appropriately phrased questions, as evidenced by the interpretation of the data, was a function of the method of instruction.

7. The audio-tapes and video-tapes used in the instruction are accurate representations of the lessons designed according to the established criteria.

8. The questions randomly selected from the pre-test and post-test are accurate representations of the questions written by all subjects in the study.

9. The questions randomly selected from the pre-test and post-test can be accurately evaluated by a group of science educators and classroom teachers provided their thoughts are guided by the criteria established for categorizing the types of questions.

Limitations of the Study

The findings in this study are restricted to generalizations about the total population on the basis of the following limitations:

1. This study was limited to the actual questions used in the classroom lessons constructed for analysis in this study. Therefore, the numbers and types of questions are limited.

2. This study was limited to two groups of methods students enrolled at a large midwestern university during the spring semester of 1968. One group of elementary education majors was enrolled in the course, The Teaching of Science in the Elementary School, which, consisted of 22 subjects. The other group, comprised of 18 subjects, was also a group of elementary education majors but these students were enrolled in an experimental program of teacher preparation called INSITE (Instructional Systems in Teacher Education). Therefore the sample was limited in number (40), geographical location, and group composition.

3. This study was limited by the ability of the investigator to

construct the instruments of instruction, to identify suitable criteria, and to describe the procedures accurately and with validity.

4. This study was limited by the ability of the investigator to instruct both groups according to plan and to present the instruction in exactly the same manner.

5. This study was limited by the degree of communication permissible through audio and video-tapes. It was limited, too, by the number of these instruments used.

6. This study was also limited by the investigators ability to instruct the panel of judges and by the accuracy with which the judges evaluated the data.

7. The scope of the instruments of instruction used in this study was limited to causing an awareness and change in the ability of prospective elementary teachers to formulate and write effectively-phrased questions.

Questions to be Answered by This Study

The procedures and instruments of instruction described in this investigation are designed to seek answers to the following questions:

1. Can prospective elementary teachers, as represented by the subjects in this study, learn to identify effectively-phrased questions through instruction?

2. Can prospective elementary teachers, as represented by the methods students in this study, learn to construct effectively-phrased questions by instruction?

3. Can prospective elementary teachers learn to identify effective and ineffective questioning techniques through a method of instruction that involves the analysis of lessons using both effective and ineffective questioning techniques?

4. Can prospective elementary teachers learn to identify poorly-phrased questions and judge more critically and accurately the effectiveness of a questioning pattern on the basis of the responses given by children as observed and analyzed from audio and video-taped lessons?

5. Can prospective elementary teachers learn by instruction to rephrase poorly-phrased questions so that they are effectively-phrased questions and hypothesize their probable responses?

6. Can prospective elementary teachers improve in their capacity to construct a greater number of divergent questions as opposed to lesser number of cognitive memory questions for science lessons as a result of instruction that involves the analysis of video-taped lessons demonstrating the use of these types of questions?

Definition of Terms

Because of the nature of this study and the pertinency of the operational definitions to the description of the instructional procedures described in this study, the investigator has defined these terms in Chapter III.

Summary

Evolving from the knowledge provided by research in child development emphasis has been given to experiences that involve children in the processes of science. The present trend is toward the teaching and learning of science as inquiry. The more noteworthy developments in elementary school science have reflected new goals for teaching and learning and have identified practices for using content as a vehicle for developing the inquiry skills.

If these efforts to improve instruction in science at the elementary school level are to be successful, teachers must be skillful at implementing these programs. This places new demands on the elementary teacher, on the prospective elementary teacher, and on those involved in programs of preparation. For this reason a great deal of attention must be given to methodologies designed to teach science as inquiry, to meet individual needs of children, and to employ activities based in the processes of science.

The use of effectively-phrased questions and the employment of effective questioning techniques can be crucial to the implementation of any methodology based on the inquiry process. Therefore, it is most important that prospective elementary teachers not only be aware of, but also be proficient in the use of effective questioning practices. It is most vital for methodologies to be developed that cause prospective teachers to be more skillful in their questioning.

CHAPTER II

RELATED RESEARCH AND LITERATURE

This investigation was concerned with the role of effective questioning as an aspect of the preparation of prospective elementary teachers for their role in the teaching of elementary school science as inquiry. The investigator attempted to review research and literature in those areas that seemed to suggest implications for this aspect of teacher preparation. Those areas investigated were organized into four categories: (1) a review of literature on the current status of the science preparation and performance of the practicing elementary school teachers; (2) a review of the literature and research that describes the importance of teacher questioning; (3) a review of literature and research that describes ineffective questioning practices; and (4) a review of the research and literature that describes more effective questioning practices.

Preparation and Performance of Elementary Teachers

Today, little doubt remains that instruction in science is accepted as an integral part of the child's elementary school experience. Most educators have recognized the emergence of elementary science as a distinct area of the curriculum. In addition, evidence from the many new programs and developments gives strong support to the premise that at no other time has it been possible to challenge young children with such advanced concepts and methods of learning. At no other time has as much emphasis been placed on and concern displayed for providing the child with experiences that improve his scientific knowledge, both in terms of breadth and depth, and develop his ability to use the processes of inquiry.

Certainly this does not dispel the dilemma for elementary teachers. For most, it merely compounds the problem. Although greater help may be available, teaching experience alone does not adequately prepare the teacher to deal with the new developments. As Fischler points out, many teachers do not understand the meaning of the inquiry process, nor do they have any comprehension of various levels of questioning.[1] Jones, Morse, and Waechter[2] predict failure, or at least only limited success, of the new elementary curricular projects, because they depend too much on the classroom teacher who has too little experience.

Although this dilemma is hardly new to educators, it is more crucial today than in the past. The need for more suitable programs of teacher preparation has been recognized for some time. Nevertheless, little has been done to change these programs, primarily because of the failure to resolve long established conflict. There are those who argue for more extensive preparation in science content while others propose a need for a more practical approach with emphasis on methods of teaching. The inadequacies elementary teachers have for teaching science, the resulting fear of science, and reluctance to teach it, have long been cited as major factors for poor instruction.

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[1] Fischler, J. H., "Science, Process, The Learner," Science Education, December, 1965, p. 402.

[2] Jones, J. C.; Morse, J. W.; and Waechter, R. F., "The Elementary School Curriculum: A Comparison of Two Methods of Introducing Science," The Science Teacher 29:17-19, April, 1962.

Although an inadequate content background in science may be a major factor, there can be little doubt that there are other factors that contribute greatly to ineffective science instruction in the elementary school. A number of studies attribute ineffectual instruction in science to non-applicable methods classes or to poor programs of preparation. Teachers contend that the mere acquisition of college credits in science will probably not guarantee improvement in science instruction in the elementary school. Witherspoon[3] found that teachers are more interested in courses that will help them present science as it should be presented in the elementary school, and Bolen's[4] recommendations included a plea by teachers for college courses that are less formal and more practical in nature. More recently, studies by Wytiaz,[5] Beringer,[6] and Washton,[7] echo the importance of providing a science program geared to the needs of elementary teachers and relating college science work to solving problems of everyday experiences. In consideration of the weaknesses of teacher preparation programs, Michals[8] contends that programs of preparation have failed because they have not shown the competency demanded of prospective teachers nor have they provided a program founded on required competencies. Simmons[9] proposes that institutions preparing teachers will have to recognize the immediate needs of teachers in the elementary school. There has been too little research into current practices and teacher needs. Few, if any, studies suggest new approaches for instruction in teacher preparation programs.[10]

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[3] Witherspoons, Gertrude, The Experiences of Beginning Teachers with Science in the Elementary School and Their Implication for Teacher Education, 309 pp.

[4] Bolen, V. A., Science Teaching Facilities and Practice in Oregon Public Schools, 177 pp.

[5] Wytiaz, P. L., "A Study of the Attitudes of Fifth Grade Teachers of Cumberland County, New Jersey, Toward Science and Their Preparation for Testing it in the Elementary School," Science Education 46:151-152, March, 1962.

[6] Beringer, M. L., "A Critical Analysis of Teacher Understanding of Scientific Fact," Dissertation Abstracts 26:2065-2066, October, 1965.

[7] Washton, N. S., "Improving Elementary Teacher Education in Science," Science Education 45:33, February, 1962.

[8] Michals, B. E., "Preparation of Teachers to Teach Elementary School Science," Science Education 47:122-131, March, 1963.

A search of the literature shows that little attention has been given to the teacher's role in activities based on inquiry or problem solving. In the past few years the focus has been on the child's role in the inquiry process. Studies by Butts and Jones,[11] Fish and Goldmark,[12] Scott,[13] Suchman,[14] and Weigand[15] reflect the emphasis on this aspect of inquiry as do the writings of Gagné[16] and Aylesworth.[17]

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[9] Simmons, R. H., "Elementary Science--A New Discipline and a Growing Responsibility of the Teacher Training College," Science Education 43:336-342, October, 1959.

[10] Dunfee, Maxine, Elementary School Science: A Guide to Current Research, p. 62.

[11] Butts, D. P., and Jones, H. L., "Inquiry Training and Problem Solving in Elementary Science Children," Journal of Research in Science Teaching 4:21-22, March, 1966.

[12] Fish, A. S., and Goldmark, Bernice, "Inquiry Method: Three Interpretations," The Science Teacher 33:13-15, February, 1966.

[13] Scott, N. C., "Science Concept Achievement and Cognitive Functions," Journal of Research in Science Teaching 2:7-16, December, 1964.

[14] Suchman, J. R., "Rebuilding the Science Program Inquiry Training in the Elementary School," The Science Teacher 27:42-49, November, 1960.

[15] Weigand, J. E., The Relative Merits of Two Methodologies for Teaching the Analysis of Children's Questions in Elementary School Science, 100 pp.

[16] Gagné, R. M., "The Learning Requirements for Inquiry," in Readings in Science Education for the Elementary School, pp. 364-372.

As Dunfee[18] points out, these studies emphasize the involvement of pupils themselves as active participants in the learning experiences associated with problem solving. She also suggests that even though much evidence is given for the value of new approaches to learning associated with inquiry and problem solving, the teachers do not find it easier. The findings of Piltz[19] in his study with teachers in Florida gives substantial evidence of the need for improvement in present approaches to methods courses. Seventy-five per cent of the teachers in this study felt totally inadequate to teach science by a process of inquiry and therefore, were unable to help children discover for themselves. It is pertinent to suggest that proficiency in questioning might dispel much of this difficulty. In a study in this area, Schippers[20] found the question-raising phase of a problem solving approach to be the greatest dilemma for teachers. Strasser[21] has emphasized the role of the teacher as a supporter of inquiry through effective questioning.

It is apparent that the teacher's role as a questioner is vital to the inquiry process particularly when one realizes that the key to

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[17] Aylesworth, T. G., "The Need for Problem Solving," Science Education 49:156, March, 1965.

[18] Dunfee, op. cit., pp. 40-41.

[19] Piltz, Albert, An Investigation of Teacher-Recognized Difficulties Encountered in the Teaching of Science in the Elementary Schools of Florida, 168 pp.

[20] Schippers, John, "An Investigation of the Grade Science Classes," Dissertation Abstracts 23:1032, November, 1962.

[21] Strasser, B. B., "Posing Productive Questions," Science and Children 4:9-10, April, 1967.

effective inquiry is questioning. Schwab[22] stresses the importance of this when he suggests that inquiry should constitute a significant portion of the teacher's preparation. This is necessary so the teacher can be prepared to comprehend inquiry and reports of inquiries and to be familiar with the kinds of questions whose answers give value to such materials. Although Schwab's concern is for the secondary school science teacher, his comments have much meaning for the preparation of elementary school teachers.

The Importance of Teacher Questioning

The writings of professional educators demonstrate the importance that has been attached to questioning by teachers. This is evidenced by the fact that teachers devote a great deal of time to this aspect of teaching. In 1912, Stevens[23] estimated that 80 per cent of the school time was devoted to question-asking sessions. Soon after this Yamada[24] pointed out that much emphasis was placed on question-and-answer periods with more than two-thirds of the class time devoted to this aspect.

More recently, in a report of his study of primary school teachers in Colorado, Floyd[25] found teachers asking from three and one-half to six and one-half questions per minute with the average teacher asking 348 questions per day. Grossier[26] suggested in 1964 that observation of classrooms would reveal that the question-answer exchange is a common practice.

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[22] Schwab, Joseph, "Inquiry, The Science Teacher and the Educator," The School Review, Winter, 1960, p. 192.

[23] Stevens, Romiett, The Question as a Measure of Efficiency in Instruction, 95 pp.

[24] Yamada, Sochichi, "A Study of Questioning," The Pedagogical Seminary 20:129-186, June, 1913.

[25] Floyd, William, An Analysis of the Oral Questioning Activity in Selected Colorado Primary Classrooms.

Many educators have recognized the oral question as an instrument of learning. Klebaner[27] points out that carefully contemplated questions, used in a meaningful sequence and at the right times, are indispensible to achieving the purposes of education. She goes on to say that since the time of Socrates to the present the role of questioning has been pivotal to learning. Klebaner[28] proposes that a question serves two objectives: the one for which it is asked and the long range goal of developing children that are independent inquirers. Issue has been made of the autonomy of learning achieved through inquiry by both Bruner[29] and Suchman.[30] Writing on the importance of questioning, Carner[31] points out that by recognizing the importance of proper questioning we can mold pupils' thinking and encourage questioning and thereby enhance more productive thinking. In the report of their cooperative research project, Taba, Levine, and Elzey[32] point out that the focus set by the teacher's question is crucial to the mental operations conducted by the student and the modes of thought he develops. Houston[33] stresses the importance of questioning by writing that teachers' questions can be the best means for bringing about pupil-initiated activity, meeting individual needs, and directing pupil development. In order to accomplish these aims, these questions must stimulate curiosity, realize a need, or require the use of facts to solve a perplexing problem.

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[26] Grossier, Philip, How to Use the Fine Art of Questioning, p. 5.

[27] Klebaner, R. P., "Questions that Teach," Grade Teacher 81:10, March, 1964.

[28] *Ibid.*, p. 10.

[29] Bruner, J. S., "The Act of Discovery," in Studying Teaching, p. 212.

[30] Suchman, J. R., "Developing Inquiry," in Inquiry Development Program, pp. 19-21.

[31] Carner, R. L., "Levels of Questioning," Education 83:546-550, May, 1963.

In writing about the influence of questioning on meaning, Horn[34] suggests that a significant amount of evidence from research shows that the way in which questions influence accuracy, completeness, and organization of meanings and concepts is vital to learning. There is probably no other means more effective than questioning to correct misconceptions and to discover more effective modes of thinking. The oral question, used skillfully, has an element of feasibility that makes it superior for diagnosing individual needs.

The important uses of questions are usually neglected for the sake of the emphasis on testing; as a result, this gives rise to many of the shortcomings of teacher questioning.[35] Horn[36] writes about the importance of questioning as revealed by its functions. He identifies the most significant functions with: (1) developing cooperation among pupils where problems meaningful to children are investigated; (2) enhancing intellectual skills as well as favorable attitudes through discovery; (3) stimulating and guiding interests; (4) developing the ability to think; (5) removing inaccuracies, misunderstandings, vagueness, and ill-organized meanings and concepts; (6) developing more aggressive attitudes toward learning and thereby influencing initial learning as well as retention; and (7) providing a more complete and accurate means of appraisal. These functions can be valuable in appraising progress and sustaining interest. They may also contribute to a greater sense of accomplishment.

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[32] Taba, Helda; Levine, Samuel; and Elzey, F. F., Thinking in Elementary School Children, 207 pp.

[33] Houston, V. M., "Improving the Quality of Classroom Questions and Questioning," Educational Administration and Supervision 24:17-28, January, 1938.

[34] Horn, Ernest, Methods of Instruction in the Social Studies, pp. 344-345.

[35] Ibid., p. 342.

[36] Ibid., pp. 342-343.

A statement by Aschner[37] indicates that progress in thinking can be measured and evaluated by asking questions and studying the responses, which, if utilized effectively, can be basic tools for stimulating further pupil thinking and learning. The asking of appropriate questions can be a means for checking the pupils' skill in organizing facts.[38] This has particular significance when one considers a common difficulty found by many studies, including this study, that teachers, and particularly prospective teachers, have difficulty pursuing ideas with children because of the inability to construct appropriate questions. This requires recognition of the appropriate questions as a first step. As Carner[39] wrote in his publication "Levels of Questioning," teachers must first recognize the importance of effective questioning as a means for molding pupils' thinking.

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[37] Aschner, M. J., "Asking Questions to Trigger Thinking," in Crucial Issues in the Teaching of Social Studies, p. 145.

[38] Pate, R. T., and Bremer, N. H., "Guiding Learning Through Skillful Questioning," The Elementary School Journal 67:417-422, May, 1967.

Waetjen[40] stresses the importance of the teacher's questions for motivating learners and stimulating curiosity. He contends that the nature of the questions used by the teacher to structure the teaching skills plays a significant role in the thinking level of pupils, the broadening of information covered and the thinking skills learned by pupils. He encourages the use of questions that require utilization of higher cognitive skills. In their analysis of classroom interaction, Gallagher and Aschner[41] have found that the kinds of questions asked by teachers evoke the same level of responses from the children. This is to say that divergent questions usually stimulate divergent thinking and convergent questions stimulate convergent thinking. The relationship between what the teacher is seeking and that with which the children respond was shown in the study by Taba, Levine, and Elzey[42] to be quite significant. The fact that it could be shown that the questions of the teaching strategy directly influenced the level of thought patterns of the children bears evidence of the impact of this aspect of the teaching strategy. At the same time, Horn[43] points out that questions that are appropriate to stimulating thinking are not easily constructed, and therefore require more extensive planning by the teacher with respect to established goals.

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[39] Carner, _op_. _cit_., p. 547.

[40] Waetjen, W. B., "Learning and Motivation, Implications for the Teaching of Science," _Science_ _Teacher_ 32:22-26, May, 1965.

[41] Aschner, M. J., and Gallager, J. J., _System_ _for_ _Classifying_ _Thought_ _Processes_ _in_ _the_ _Context_ _of_ _Verbal_ _Interaction_, ditto.

[42] Taba, Levine, and Elzey, _op_. _cit_., p. 177.

[43] Horn, _op_. _cit_., p. 344.

It appears that to some degree an element of mystique has been attached to questioning practices. Some writers[44] suggest that effective questioning is an art or innate talent while others[45] contend that it is a skill that must be developed through study, thought and continuous self-evaluation.

Ineffective Questioning Practices

For the most part the studies on and related to questions and questioning practices have focused on identifying questioning practices carried out by teachers. Most of the conclusions from these studies emphasize the ineffective practices. Nevertheless, the findings of these studies lay important groundwork for this study. Practices that involve asking rapid-fire questions, emphasizing factual-type questions, including parenthetical phrases, using elliptical questions, accepting inaccurate answers, failing to hold to a question, and depending on a "spontaneous generation approach" to formulating questions, bear important consideration for this study and are evidenced by their commonality in the findings of many other studies.

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[44] Carner, *op. cit.*, p. 447; Hamann, I. M., "Art of Questioning," *Journal of Education* 119:42, January, 1936; Sanders, N. M., *Classroom Questions, What Kinds*? p. 2.

[45] Kelbaner, *op. cit.*, p. 77; Taba, Levine, and Elzey, *op. cit.* p. 1.

In her study of 1912, Stevens[46] found both the rapidity of questioning and the asking of factual recall questions to be typical practices. The rapidity of questioning was most striking in the findings of Stevens. She found an average of one question asked and a response given every two minutes. In Stevens' opinion the practice of asking a large number of questions during [illegible] lesson reflects evidence of the following:

1. Much time on classroom maintenance
2. Teacher oriented discussions
3. Emphasis on verbal memory and superficial judgment
4. Lack of time for verbal expression
5. Lack of thought for individual needs
6. Development of teacher-dependent-pupils.[47]

On the other hand, Horn[48] suggests that rapidity of questioning should be criticized in its proper perspective, that of its function. Horn does not agree with Stevens on the undesirability of rapid-fire questions. He feels that this technique has its place in checking or clarifying important factual information, stimulating simple deductions, and giving vitality and direction to weak discussion sessions. At the same time he stipulates that this technique must be subordinate to questioning that arouses interest, develops thinking, and relates ideas.

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[46] Stevens, _op_. _cit_., pp. 11-15.

[47] _Ibid_., pp. 17-26.

[48] Horn, _op_. _cit_., p. 350.

Yamada, in his Study of Questioning in 1912, comments that demanding rapid-fire answers cheats the child of time to suspend judgment and weigh all the facts. It not only prevents him from recalling concrete experiences and relating them for an effective response but encourages him to react in a random manner using any suggestion that comes to mind. Yamada[49] suggested that this results in a sort of mechanistic response set characterized by instinctive, premature responses. With this in mind, situations of verbal behavior in the classroom reveal a number of cases where the child does not know the correct answer but he very shrewdly manipulates the "expected" correct answer from the teacher by testing a variety of possible responses. As a result he develops a very illogical thought pattern, if any at all.

Stevens[50] relates that a practice of asking 79 questions in a single class period is unreasonable if the teacher is going to provide for assimilation and association of ideas as well as orderly expression. She suggests further that it is not necessary to create nervous tensions in students when the same purpose can be accomplished by asking fewer but better questions. Stevens questioned the validity of asking as many as 150 questions in a 40 minute period if the purpose of a question is to stimulate thought and provoke verbal expression, suggesting that the results could only be negative.

The over-dependence on questions that require factual recall has been discussed by many writers and cited by several researchers. In a study on questioning, as it relates to reading in the elementary school,

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[49] Yamada, op. cit., p. 177.

[50] Stevens, op. cit., p. 7.

Guszak[51] found that 59 per cent of the questions were recall-type. He concluded from his study that recall questions actually lead students away from basic understanding and as a result they miss the literal understandings. Dodl[52] found that content discussions accounted for 60 per cent of the questions asked. In a recent study with elementary teachers, Schreiber[53] found factual-recall questions to be by far the most common kinds of questions used by teachers in all three types of lessons examined in her study. The very high percentages shown in the findings of the studies by Moyer,[54] Adams,[55] and Gagnon[56] support these findings. Hunkins[57] reports that transcripts from recent research in elementary classrooms show teachers have not contemplated the phrasing of their questions or what should be emphasized by the question. This was reflected in the spontaneous nature of the questions and resulted in questions that stressed memory of specific facts despite the teachers' expressed concern for developing thinking. Horn[58] warns that extensive emphasis on verbal memory in questioning can harm the child intellectually by creating close-mindedness and by distorting ideas.

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[51] Guszak, F. J., "Teacher Questioning and Reading," Reading Teacher 21:227-234, December, 1967.

[52] Dodl, N. R., Pupil Questioning Behavior in the Context of Classroom Interaction, pp. 6441-6442.

[53] Schreiber, J. E., Teacher's Question-Asking Techniques, 224 pp.

[54] Moyer, J. R., An Exploratory Study of Questioning in the Instructional Processes in Selected Elementary Schools, 281 pp.

[55] Adams, Thomas, "The Development of a Method for Analysis of Questions Asked by Teachers in Classroom Discussion," Dissertation Abstracts 25:2809-2810, November-December, 1964.

[56] Gagnon, A. L., "An Analysis of an Experimental Methodology for Teaching, Thinking and Clarifying Values," Dissertation Abstracts 25:1293A, 1965.

[57] Hunkins, F. P., "Using Questions to Foster Pupils Thinking," Education 87:83-87, October, 1966.

The phrasing of ambiguous questions; the asking of questions that, because of their difficulty, do not permit good mental reactions; and the failure of the teacher to pursue a question long enough to complete the thought process were found to be common causes of poor responses.[59] Teachers' acceptance of careless or incorrect answers without questioning the pupil more extensively appears to be one of the most glaring deterrents to effective questioning. Horn[60] goes on to point out some of the characteristics of ineffective or "wrong" kinds of questions. These are questions that can be answered with one word or a yes or no response. These are also questions that require fixed responses rather than broadening the understanding of the content being questioned. Batchelder, McGlasson and Shorling[61] suggest that a common fault of questions asked by teachers is that they include parenthetical phrases which confuse students and contribute to guessing. Stevens[62] relates that questions are sometimes too difficult to provide for adequate thought and organization of an appropriate answer. She further suggests that when this is coupled with acceptance of a poor response by the teacher it contributes to ineffective intellectual development by the child. Stevens supports these statements with numerous examples. In addition these statements and examples substantiate the premise on which this study is based. It is also interesting to note that the findings in a preliminary investigation by the investigator in his study, to establish criteria for questioning used in the instruction for the study, clearly indicate that little has changed since 1912 when Stevens published her study. The same practices are obviously evident. This stresses the need for a means of preparing teachers to adequately deal with this important aspect of teaching. Moyer[63] found that questions could be categorized in structural forms, with identifiable grammatical arrangements that affect the nature of the response elicited. From this he found that almost all the questions asked demanded factual information, reasons, explanations or yes-no answers as responses. Although evidence is not available to support this, it does appear that many poorly structured questions would contribute to confusion and misunderstanding on the part of pupils. The findings in Moyer's[64] study demonstrate the importance of a logical and distinct word order for clarity in questioning. He demonstrated examples from the transcripts that he collected of questions that were inverted or elliptical, statements implied as questions, double or dual questions, and one word questions. Some examples from the investigators' study of these questions are the following:

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[58] Horn, _op_. _cit_., p. 356.

[59] Stevens, _op_. _cit_., p. 78.

[60] Horn, _op_. _cit_., p. 349.

[61] Batchelder, McGlasson, and Shorling, _op_. _cit_., p. 173.

[62] Stevens, _op_. _cit_., p. 81.

"Is this the correct answer?"

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[63] Moyer, op. cit., p. 210.

[64] Ibid., p. 211.

"Do you notice anything different about this?"

"You have learned a lot about water, haven't you?"

"A bullet?"

"Here?"

"Same thing would happen?"

The large number of "unclassified questions," questions not belonging to one of his categories on the basis of the absence of the seven basic interrogative terms (who, what, which, why, how, where, when) identified by Moyer,[65] gives cause for alarm and points to a need for improving teacher questioning. He found that nearly one-half or 43 per cent of the questions he collected fell into this category. The fact that Moyer's examination revealed that almost all of these questions could be answered with a yes or no, and in some cases a nonverbal response, suggests that teachers need to avoid the practice of using these questions. Moyer[66] hypothesized that this is probably the source of many problems of accurate communication in learning situations. Examples of unclassified questions similar to those Moyer found include:

"It gets bigger?"

"Think gravitational force is always identical?"

"So it's not too far off?"

"All of them moved?"

"Then this would form a rock then?"

He found that most of these questions could, with rephrasing, be more functional if they included one of the interrogative terms.

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[65] _Ibid_., pp. 82-83.

[66] _Ibid_., p. 84.

Effective Questioning Practices

Much less has been written about effective questions and questioning practices. Some noteworthy efforts have been made to identify more suitable questions and questioning practices but little research is available that demonstrates the effects of these more desirable questions or practices on learning.

Houston[67] suggests that the better questions, those that cause pupil initiated activity and guide independent study, are those that stimulate curiosity, arouse a feeling of need or require using facts in solving some challenging problem. Hamann[68] identifies the "good questions" by the thought the question provokes as judged from the discussion interest and expression of thought shown by children. A "good question" can be noted by its clarity. And Hunkins[69] writes that "good questions" clearly relate to the established objectives of the lesson. Therefore, careful planning is required of the teacher to develop appropriate objectives and questions that lead to achievement of these objectives. Hunkins[70] goes on to point out that questions cannot be used apart from other techniques and neither can their value be determined by any single criterion. He suggests also that the level of thinking elicited depends heavily on the information that the respondee brings to the question. Klebaner[71] suggests that appropriateness and flexibility are two important criteria. These are important considerations when thinking of questions for different learning situations. Nevertheless, it appears obvious that criteria for effective questions and questioning practices are difficult to identify particularly when the questions cannot be dealt with out of context.

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[67] Houston, *op. cit.*, p. 19.

[68] Hamann, *op. cit.*, p. 42

[69] Hunkins, *op. cit.*, p. 84.

[70] *Ibid.*, p. 85.

In her discussion on the quality of questions, Stevens sets three elements that serve as guidelines for a good question. The "good question," according to Stevens, stimulates the kind of reflection characteristic of that required in responding to a problem-type question. In addition, this kind of question is one that relates meaningfully to the experience of the children. Stevens also describes the "good question" as one that develops completeness of thought, with the highest level of questioning being one that stimulates continued activity in the adult mind. These are questions that call for making associations of ideas, the potency of which can be measured only by the answer given. The "good questions" should aim to develop accuracy and thoroughness.[72]

The major reason for "good questions" not being asked is that they are not thought out and incorporated into the lesson plan. Teachers do not ask questions that demand association of ideas by calling for comparisons nor do they ask questions that demand a great deal of reflection because they find it easier to ask a number of questions rather than organize the content and clarify their goals.[73] Stevens implies that nothing is more crucial to the effectiveness of a lesson than the planned question. As many others have upheld more recently, Stevens feels that teachers could more successfully realize the intent of their lessons if they were to include a few thought-provoking questions that are based on the lesson and call for the making of associations and discriminations in addition to weighing of values.[74]

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[71] Klebaner, op. cit., p. 77.

[72] Stevens, op. cit., pp. 75-79.

[73] Ibid., p. 81.

In an attempt to help teachers formulate and use more effective questions and questioning techniques, educators have suggested a number of guidelines. These suggested guidelines are quite common in the literature but their value must be questioned since it is doubtful that they ever get into the hands of teachers. These guidelines are far too numerous to describe here but a few examples are quite representative. In her article entitled "Questions that Teach," Klebaner[75] lists some suggestions for construction and evaluation of teachers' questions based on such factors as appropriate timing, clarity, flexibility, and logical sequencing. In his study that involved a plan for improving the quality of questions and questioning practices used by social studies teachers in junior high schools of New York City, Houston[76] describes criteria for evaluating questions and techniques that have been developed by supervisors and approved by teachers. From his study in 1912, Yamada[77] identified some qualities inherent in good questions that are still very applicable today. Most of these guidelines stress factors related to the function of a question, its relationship to the experience of the children, and the wording of the question.

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[74] Ibid., pp. 84-85.

[75] Klebaner, op. cit., pp. 10, 76.

[76] Houston, op. cit., p. 22.

[77] Yamada, op. cit., p. 26.

Although evidence from the literature indicates that little has been done to improve the ability of teachers to ask effective questions, a number of categories or systems for classifying questions have evolved from efforts to improve questioning practices. Many have been through a means of studying classroom verbal behavior while others represent direct attempts to identify questioning practices as a specific focus. But seldom has questioning been isolated as a single concern for analysis and even fewer attempts have been made to cause change in the questioning ability of teachers. The classification schemes and the data from these studies serve as important bases for identifying strategies for instruction in questioning procedures. A few of these efforts represent attempts to establish a hierarchy for questioning.

Using the taxonomy that Bloom and his colleagues had established for classifying educational objectives, Sanders describes sequential classes or types of questions. His "taxonomy of questions" is as follows:

> 1. Memory: The student recalls or recognizes information.
>
> 2. Translation: The student changes information into a different symbolic form or language.
>
> 3. Interpretation: The student discovers relationships among facts, generalizations, definitions, values, and skills.
>
> 4. Application: The student solves a life-like problem that requires the identification of the issue and the selection and use of appropriate generalizations and skill.

5. Analysis: The student solves a problem in the light of conscious knowledge of the parts and forms of thinking.

6. Synthesis: The student solves a problem that requires original, creative thinking.

7. Evaluation: The student makes a judgment of good or bad, right or wrong, according to standards he designates.[78]

Smith and Meux,[79] in their cooperative research project, identified 13 basic categories for classifying questions based on the "logical operations." These "logical operations" are defined as the forms which verbal behavior takes as the teacher constructs and develops the content during the act of teaching. These "logical operations" include defining, explaining, stating, designating, reporting, substituting, evaluating, opining, classifying, comparing and contrasting, conditional inferring, and directing and explaining. Again, a hierarchy of question-asking is implied. Although this system is directed to all verbal behavior, the categories are most appropriate for describing questions and questioning patterns. The investigators used the entry of episodes as the basis for their classification scheme. For the most part, an entry was the teacher's question that tends to shape the character of the episode and controls the continuing phase of the episode. The depth analysis of the episode provides pertinent information about the entry, the teacher's question, and its effectiveness.

From Guilford's model of intellectual performance, Gallagher and

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[78] Sanders, op. cit., p. 3.

[79] Smith, B. O., and Meux, M. D., A Study of the Logic of Teaching, pp. 2-11.

Aschner[80] have developed a four-category system designed to suggest the kinds of questions that elicit responses from the different cognitive levels. This scheme suggests questions for cognitive memory, convergent thinking, divergent thinking, and evaluative thinking. In their study of classroom verbal behavior, Aschner and Gallagher[81] concerned themselves only with the operations dimension of Guilford's model. From this they identified the four classification categories which permit a rather simple method for analyzing cognitive behavior in the classroom and are of major interest in this study.

In this system, as in some others, the key entry that identifies the verbal activity with a particular category is the teacher's question. It is also apparent in this system that a loosely connected hierarchy exists that permits describing objectively and accurately the nature of the cognitive behavior in a given classroom situation. It is also important to point out that Aschner and Gallagher[82] operated on the assumption, drawn from the data of their study, that a question asked at a given level will elicit a response that can be identified with that same level. This is to say that cognitive-memory, the lowest level question, will bring about cognitive-memory responses. The level of the teacher's question, then, will be a vital determinant for the kind of thinking and responding that follows. Therefore, the questions asked by a teacher can be identified with one of these cognitive classifications and the resulting responses analyzed in relation to the category to describe the cognitive development that is evolving.

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[80] Gallagher, J. J., Productive Thinking of Gifted Children, pp. 22-34.

[81] Ibid., p. 23.

[82] Ibid., p. 32.

The four categories described by Aschner and Gallagher are cognitive-memory, convergent, divergent, and evaluative. The first of these, cognitive-memory questions, demands recall, memory, or recognition. They are usually narrow questions calling for reproduction of facts or responses in the form of yes or no answers. The convergent category includes more broad types of questions that demand integrating facts usually leading to one conclusive answer. Divergent questions usually lead to responses that are more creative and imaginative while evaluative questions involve making some value judgment that requires organizing one's knowledge to take a self-selected position.[83] Each of these main categories is composed of subcategories that have been developed empirically from studying classroom performance. Since these categories are described in more detail in Chapter III, they are only identified at this point.

These categories are also described by Amidon and Hunter in relation to their Verbal Interaction Category System (VICS) which provides for identifying broad and narrow questions and predictable and unpredictable responses. In this interaction analysis scheme, Amidon and Hunter define narrow questions as those that are factual recall questions, requiring very short replies or yes-or-no answers; usually the nature of the response can be predicted. Predictable responses are identified with the pupil response categories and described as those short answer replies that usually follow a narrow question. Broad questions are the more open-ended questions that call for unpredictable responses, usually these are thought-provoking questions. And unpredictable responses are those that usually follow this kind of question.[84] The Verbal Interaction Category System provides a rather simple means for categorizing questions and their related responses. It can serve as a starting point for a teacher to analyze and assess the effectiveness of his questioning.

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[83] Ibid., p. 25.

Following the lead of Fristae[85] and Smith,[86] and with a primary concern for identifying the types of questions elementary teachers ask in science lessons in terms of grammatical structure and function of questions, Moyer[87] identified 13 basic categories based on question function. In his study Moyer identified function with the nature of the response, while structure was described in terms of the basic form and organization of the question. Moyer identified questions in relation to what he called the seven basic "interogatory terms"--what, why, how, who, where, which, and when. He found that use of these terms usually required some factual answer, reason, or explanation. He also showed that questions employing these terms required more than a yes-no response, while questions that began with an auxillary verb like can, are, will, or may, usually resulted in a yes-no response.

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[84] Amidon, Edmond, and Hunter, Elizabeth, Improving Teaching, pp. 8-13, 26-28.

[85] Fristae, J. U., "Questions," School and Community 50:15, March, 1964.

[86] Smith and Meux, op. cit., pp. 2-11.

[87] Moyer, op. cit., p. 119.

The structure of the question was viewed in terms of the basic form and organization of the question with the following criteria:

1. Nature and logic of the language
2. Arrangement of words in the question
3. Complexity of the vocabulary used
4. Accuracy of the words in relation to experiences, academic ability of the children and the meaning intended by the question.[88]

The function, based on the responses, included two identifiable general purposes. The less useful purposes were questions used as statements or exclamations to find information, to present explanations, to give directions, to make commands or requests. To scold, warn, praise, or evaluate were also considered less desirable purposes for questioning. More useful purposes included questions used to develop inquiry skills, to stimulate thinking, to bring about reasoning and evaluating, to explore content, or to construct experiences. From the 2,500 questions collected from elementary classroom observations and his 13 basic categories, Moyer constructed 37 function categories. The function was viewed in terms of what it caused the child to do in his response and the degree of adequacy with which the child responded.[89] Moyer's procedure for classifying questions, both in terms of function and structure, provides some pertinent information for identifying problem areas of questioning that need to be overcome to cause improvement in questioning practices.

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[88] _Ibid._, p. 79.

[89] _Ibid._, pp. 124-128.

A study of questioning practices, as they are used in social studies lessons by elementary school teachers, gives pertinent evidence for the need and value of instruction in questioning. In her study with 14 elementary teachers, Schreiber[90] found that the frequency of questions asked that called for recall of facts by children was very high prior to instruction. At the same time, she demonstrated that question-types that were not as frequent prior to instruction could be substantially increased in the frequency of their use through instruction. As a result of a four hour instructional period with the teachers involved in the study, she found a significant reduction in the number of factual-recall questions asked in the three types of lessons analyzed in the investigation. The instructional periods involved examination and evaluation of different types of questions and questioning practices. The implications for the benefits derived through instruction on questioning, as shown by Schreiber's results, substantiate the value and need for this study. The utility of a method of instruction using audio-taped lessons as a basis for analysis of questions and questioning practices, as observed from Schreiber's research, also bears evidence of the validity of the approaches used in this study.

From the results of her study, Schreiber[91] suggests that many teachers would benefit from instruction on how to improve their question-asking practices. She also suggests a need for emphasis on purposes, types, and guidelines for more effective questions in college courses preparing teachers. Schreiber further suggests that experiences in constructing questions would be beneficial to prospective teachers.

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[90] Schreiber, _op_. _cit_., pp. 157-158.

[91] _Ibid_., p. 162.

Summary

From the discussion of the literature and research above, it is apparent that the oral question is of importance, if for no other reason than its extensive use by teachers. Also significant is the fact that many have attached importance to questioning because of the benefits to learning that can be derived from its effective usage. Therefore, the quality of questions and questioning practices used by teachers is vital to meaningful learning. The significance of the effective question to fruitful learning cannot be denied. Studies have shown the direct relationship between the questions asked by teachers and the modes of thought that children learn.

There is a great deal of evidence to show that effective use of the oral question presents a real dilemma to elementary school teachers. Numerous ineffective uses of questions and questioning techniques have been described by professional educators. A probable reason for these defects is the lack of attention given to the questioning aspect of the teaching act and the lack of attention given to designing methodologies that could more adequately prepare teachers to construct effective questions. Because methods classes stress the knowledge and psychology of teaching rather than examining the teaching act itself, too little attention is given to specific elements of a teaching strategy.

Beginning teachers should not be left to take a haphazard approach to questioning. As many writers propose, and as a few studies have shown, changes in the questioning ability of teachers can be made when attention is given to this aspect of teaching. Prospective teachers should be made familiar with the functions of different types of questions. They should also learn the means for developing and incorporating a framework of effective questions in the plan of a lesson. It is doubtful that mere practice will satisfy the need since it is obvious from the literature that teachers get extensive practice in asking questions. When a conscious concern for studying, analyzing, and criticizing questions and questioning practices can be established with prospective elementary teachers, it is more likely that they will develop a habit of using more effective questions and questioning practices.

The success of broader approaches to teaching is doubtful as long as questioning presents a problem for teachers. It is unlikely that elementary teachers will be able to successfully employ the contemporary curriculum programs based on the inquiry processes without first developing a degree of skill in the use of effective questions and questioning techniques. It is possible that much of the dilemma elementary teachers face in constructing and executing appropriate science experiences could be dispelled with confidence in their questioning ability and skill in formulating questions that support inquiry development. It is also apparent from the literature, that to have this confidence and skill, prospective elementary teachers should experience in their methods courses opportunities to develop those skills and abilities that result in more effective uses of questions and questioning techniques.

CHAPTER III

PROCEDURES AND INSTRUMENTS USED IN THIS STUDY

This study seeks to improve the ability of prospective elementary teachers to recognize and construct effectively-phrased questions for developing inquiry activities in the teaching of science. To accomplish this purpose the study is designed as a descriptive study. Therefore, the data collected is descriptive in nature and dependent upon the instructional procedures and instruments designed by the investigator. Items for instruction were developed from described literature and research, analyses of classroom observations, and a pilot study designed and implemented by the investigator. The procedures involved in designing and implementing the instruments and methodology used in this study were developed over an extended period of time. Therefore, these procedures are described here in accordance with their order in the construction and execution of the study. The descriptions contained within this chapter include the procedures preliminary to the study, the construction and use of the pre- and post-measures, the instruments of instruction used in various phases of the study, the methodology used in the instruction, and the operational definitions for the study.

Preliminary Procedures

Establishing Criteria

One year prior to the study, the investigator began making audiotapes of classroom science lessons conducted by prospective elementary teachers. These lessons were conducted in two different types of situations. One of these was in the classroom where the prospective teacher was conducting a lesson with the entire class. The second was organized and incorporated into the methods course, a situation in which the prospective teacher conducted a 20-minute science lesson with 8 to 10 children. From these two types of lesson situations 55 audio-taped lessons were selected for analysis by the investigator. The purpose of these analyses was to describe criteria that could be used to identify poorly-phrased questions, ineffective questioning techniques, effectively-phrased questions, and effective questioning techniques. In addition, the analysis of these lessons served to support the examples of common practices of both ineffective and effective questioning cited in the literature and research. These criteria were then identified and incorporated into the plan for instruction in a pilot study. The selected criteria permitted a basis for describing the instructional procedures and the instruments used in the instruction. They also served as guidelines for analyzing the video-taped lessons that were the central focus of the instructional program.

The Pilot Study

During the semester preceding the study, the investigator designed a four-class-period instructional program for the purpose of testing the effectiveness of

1. Instruction using audio and video-taped lessons
2. An instrument that would serve as a pre- and post-measure
3. The use of the four category system as a means for identifying different types of questions

4. The established criteria described by the investigator for identifying questions according to their phraseology and usage (technique)
5. The time allowed for instruction
6. The analysis-discussion approach to instruction.

The subjects included in this pilot study were 25 elementary education majors that were preparing to initiate their student teaching and, at this point in the methods course, were teaching in elementary classrooms on a part-time basis.

The instrument that would later serve as the basis for the design of the pre- and post-test instruments of the study was administered on the first day. On the second day the questions presented in the instrument and the reconstructed questions written by the students were discussed for the purpose of identifying criteria for distinguishing poorer questions from more effective questions. The third day the students used a modification of the Verbal Interaction Category System to analyze a video-taped lesson for the purpose of identifying broad and narrow types of questions and their related responses. The video-taped lesson from which the preliminary test instrument was drawn was shown on the fourth day. This lesson was discussed and evaluated in relation to the identified questioning pattern. Upon completion of this discussion, the students were introduced to the four category system (Appendix G). Sample questions were classified according to this scheme as they appeared in the transcribed dialogue of the observed lesson. An analysis was made of the video-taped lesson on the basis of the types of questions identified with the four different categories. The fourth period of instruction ended with a "brainstorming" session where the students constructed questions for a single concept, observed on a two-minute silent film.

The pilot study demonstrated a need for

1. Clearer and more carefully designed video-taped lessons in order to illustrate the differences in using certain types of questions and questioning patterns
2. A more gradual exposure to means for distinguishing questions and questioning techniques and, therefore, a more logical development of the analyses
3. More concrete experiences with questions and questioning techniques with a longer time for the analyses
4. Emphasis on the context of questions in order to consider their function
5. Clarification of the criteria in order to identify the contrasting types of questions and questioning techniques.

The investigator felt that the open-ended design of the test instrument was both necessary and desirable to permit students the freedom to construct questions according to specified criteria. In the judgment of the investigator this instrument was effective for this purpose on the basis of the pilot-study results. Therefore, serving its purpose for investigation of the central problem of this study. The use of video- and audio-tapes as a basis for the instruction also appeared appropriate. The merit of the "brainstorming" technique was evidenced in the number of questions constructed by each individual and the quality of discussion that centered around these questions.

A more extensive search of the literature and a more thorough analysis of the 55 audio-taped lessons helped to specify the criteria for poorer and more effective questions. These then served as the basis for two video-taped lessons that were planned and cooperatively structured by the investigator and a classroom teacher to illustrate lessons characteristic of these criteria. The instructional period was extended to seven days, and three written assignments were designed to provide time and guidelines for analyzing the observed lessons. The pre- and post-measures were redesigned to keep the questions in the context of the lessons used. Therefore, the instruments and instructional procedures used in the study were more clearly defined from the results of the pilot study.

Procedures and Instruments

During the class period that immediately preceded the first day of instruction, the investigator administered a written activity that served as a pre-measure for the questioning ability of the methods students involved in this study (Appendix B). The questioning ability, at this point, is thought of primarily in terms of the way in which the subjects phrase questions and the questioning techniques they reconstruct for use with the lesson used in this pre-measure. The four items that comprised this pre-test measure required the student to reconstruct, according to specified criteria, the questions and questioning techniques used by the teacher who was conducting the lesson. Because these students were assumed to have no prior instruction in questioning, the instrument was based on the assumption that they did not have criteria on which to evaluate different types of questions. Therefore, some simple or familiar concepts to serve as criteria were necessary. These criteria were carefully selected for their relation to the criteria used in the study but stated in terms familiar to the students from their previous work in the methods course and incorporated into the instructions for each item. Since the primary concern of this study was with describing the effectiveness of the method of instruction for increasing the capacity for writing effective and/or divergent questions, the investigator did not choose to validate this instrument prior to its use. The investigator believed that the descriptive nature of this study and circumstances that required construction of questions on the part of individual students did not permit establishing validity. A similar measure was used during the class period that immediately followed the last day of instruction.

Both the pre-test measure (Appendix B) and post-test measure (Appendix H) consisted of the following elements:

1. A 20-minute audio-tape of a science lesson conducted by a student teacher working with a class of second-grade children (third grade for post-test)
2. A transcribed dialogue of this lesson
3. The materials being used by the children and teacher in the lesson being analyzed
4. The written activity that required constructing, reconstructing, and sequencing questions for specified segments of this lesson as it was heard on audio-tape and described by the dialogue.

In order to pass judgment on the questions being analyzed, the students writing this activity had to consider the questions asked by the teacher and the responses given by the children. Then it was necessary for them to reconstruct a plan for a given segment of a lesson, following the objective and the activity used in the lesson, but changing the questioning pattern according to the criteria specified in the instructions.

The criteria or purposes for reconstructing the questioning for these lessons include the following:

1. Brainstorming questions--involves formulating as many questions as possible about a given situation or problem. Here the emphasis is on the quantity of questions that can be recorded rather than the quality.

2. Designing or rephrasing a question that is most effective for initiating a lesson, part of a lesson, or a discussion. This question should relate to the objective of the lesson, clarify the problem in the lesson and/or seek to establish interest in the lesson.

3. Stating or rephrasing a question or questions that would encourage broad or unpredictable responses. These are questions that would encourage several different but related responses. Therefore, these are questions that would stimulate increased participation in the discussion.

4. Identifying questions that would result in responses that are more descriptive of events or objects observed by the children.

5. Constructing questions that would cause the children to interpret and relate observations made on some event or object. These are questions that focus on important relationships that will lead the

children to draw a conclusion.

6. Designing questions that extend considerations related to the central problem to other aspects. These questions cause responses that lead to further experimentation, more extensive exploration of the content, or depth investigation of an activity.

7. Formulating questions that cause children to make alternative predictions, state hypotheses, or make inferences. These are questions that cause the children to suggest variables that could be introduced and to predict what would happen if some condition were changed. These would include questions that ask a child to suggest what would happen in some hypothetical situation.

8. Causing a child to clarify his response; giving direction to the lesson leading to accomplishing the expressed objective of the lesson; and developing understanding of the basic concept(s) involved in the central problem of the lesson are purposes implied or included in the above.

The investigator initiated these two sessions with the following verbal instructions:

> You are about to listen to an audio-tape replay of a science lesson conducted by a student teacher while working with a class of second-grade children. The tape will be played once. You also have in your hands a transcribed copy of the dialogue of this lesson. The dialogue consists of the questions asked by the student teacher and the responses given by the children. Except where it has been necessary, all other verbal interaction has been left out. Listen to the replay of this lesson carefully and follow along by referring to the dialogue. In addition you have the materials used by the children and teacher in the lesson. You may manipulate these materials, as is done in the lesson, so that you better understand the context of the lesson. When the lesson is finished you will be given a written activity that will ask you to rework some of the questions used in this lesson. When you receive your copy,

> read the descriptions and instructions carefully and write out all information requested of you. Since the instructions call for referring to the dialogue, keep it available for easy reference. The activity is not long so that you have time to think about your response carefully and completely. It will be important for you to complete the activity to the best of your ability.

The completed tests were collected from each student, and the questions written on each item were tabulated for later evaluation by the investigator and the panel of judges.

Some Basic Considerations

The method of phrasing a question can be analyzed on two distinctly different but closely related bases, one of function and one of structure. It is the functional aspect that is of greatest importance in this study. The function of a question is a determiner of the level of response given by the child. Therefore, the evidence of thought in a verbal expression in reply to a question may be shaped by the question itself. Because the response reflects the criteria established by the question, the phrasing of a question will be an important factor in controlling the response and the related thought. The nature of the responses elicited by a particular type of question or a characteristic phrasing of a question is crucial to the criteria and the established goals used in this study.

While the function of a question relates to the response it elicits or the desired response implied by the question, the structure of a question pertains to its grammatical nature. The word order and extent of the wording of a question are important considerations. The wording here is a determiner for the clarity of a question since using too few or too many words can detract from its clarity. Therefore, the

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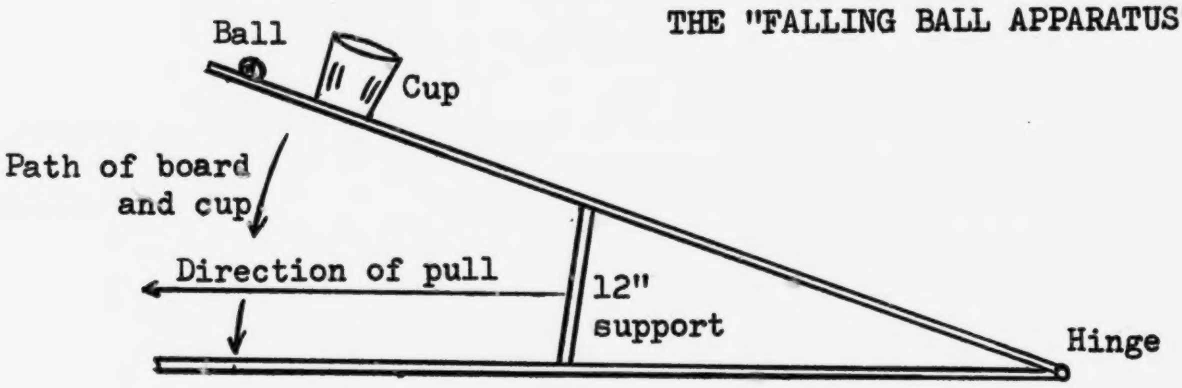
investigator sees a one word question as distinctly different from a clearer question where more descriptive terms are used to clarify the intent of the question. For example, a question like, "Why?" must be considered less desirable than a question like, "Why do you think the can will fall when the two wires are separated?" Although grammatically inverted questions must be considered less desirable than questions with a distinct word order, the investigator found situations where there was no apparent detrimental effect of poor structuring in this case. The structure of a question must be considered in conjunction with the function; because the structure used in the phrasing of a question can be a contributor to misunderstandings, guessing responses, and unresponsiveness as a result of not understanding the question or the problem as presented by the question. For example, "Make it easier to what?" or "What did we say about them in relation to what?" are questions which are considered less desirable than "What predictions can you make about what is going to happen to the marbles?" Other contrasting examples include, "Do you think it will make any difference if I blow harder or softer?" as opposed to "What differences do you think it would make if I were to blow softer?" and "What ideas do you have about how we could set up the apparatus in order to get the candle into the can?" as opposed to "What do you think should happen, if I had this set up right?"

The major goal for the methodology used in this study was to bring about a positive change in the capacity that prospective elementary teachers have for constructing effectively-phrased questions for elementary school science lessons. The eventual accomplishment of this goal was sought by gradually introducing the subjects to the criteria for identifying effectively-phrased questions primarily by means of videotaped science lessons from elementary school classrooms. Therefore, the instruction in this study was divided into specified phases to reach this goal.

Phase One: Establishing Initial Questioning Ability

The instruction began by involving the methods students in a particular question-asking task by requiring them, both as a group and as individuals, to construct a questioning pattern for a single demonstration lesson that was to be used in an elementary school classroom with fifth-grade children. The demonstration used in this phase of the instruction was designed to illustrate the interaction of a freely falling body with an object whose path of falling has been controlled. The following is a diagram of the apparatus used to demonstrate this concept:

THE "FALLING BALL APPARATUS"



The apparatus consists of two boards that are one-quarter of an inch thick, two inches wide, and 36 inches long. These two boards are hinged together at one end. The top board has a plastic cup fixed to it and an indentation near the unhinged end. The top board is supported above the bottom board by a 12-inch ruler placed in a specified position. This position is determined by a notch in each of the two boards.

The demonstration proceeded as follows:

1. The ball was placed in the indentation of the upper board (any size ball that can remain in the indentation as well as fit into the cup can be used)
2. and the support was pulled out. This caused
    a. the top board with its attached cup to land on the bottom board
    b. the ball to be released and fall in a vertical path into the appropriately placed cup.

This apparatus is commonly referred to as the "falling ball apparatus."

This initial demonstration served as a means or catalyst to elicit questions from the subjects without their having had previous instruction in phrasing effective questions. This procedure, then, served as a means for establishing the starting point for developing their questioning ability. The instructional approach used to construct the questioning pattern that was to comprise the lesson for a fifth-grade class is described in the section which considers the method of instruction.

The nature of this lesson to be used in a fifth-grade class depended to a great extent on the questions designed for the demonstration by the methods students. Despite this circumstance, the investigator took this lesson to a fifth-grade class and initiated it using the following introduction:

> I have several different objects here. In a minute we are going to use all of those objects to see if we can solve a problem. Most of these objects are very simple things, but it will be very important to have as much information as we can about what these objects are and how they are connected so that we can solve our problem without too much trouble. Let's start by

> having you tell me as much as you can about these things. What are some of the things that you can observe about these objects?

After the fifth-grade children had given their descriptions, the investigator filled in additional necessary information to describe the apparatus. Then the investigator arranged the apparatus as it has been described previously and proceeded with the lesson and the questioning as it had been designed by the methods students. The lesson was held as nearly as possible to 20 minutes. It was video-taped for analysis by the methods students on the seventh day of instruction.

The demonstration was also conducted in three other fifth-grade classrooms where the children were requested to ask questions about the demonstration. These questions were to be considered in the analysis made of the lesson designed by the methods students. This technique permitted them to compare their questions with the interests of the children as expressed in their questions about the demonstration. When the demonstration was carried out in these other three classrooms, the investigator used the following approach:

> Notice that I have several objects here that I am going to use to demonstrate a problem to you. I am not going to tell you what these objects are right now nor do I want you to tell me. I will hold them up so you can see them clearly. Now, what I am going to do is to set these objects up this way (arranged as described previously), and I want you to watch very closely to see how much you can observe. I am going to do something to change the way that these objects are set up. When I do this, the change takes place very quickly so you will have to watch carefully. So that you will have a better chance to see what happens, I will do it three times. What I want you to do is, after you have watched it closely for the three times, to think about it and then write down two questions that you would like answered about what happens. Try to make them different questions.

After the children had completed the writing, the investigator returned to the demonstration and pursued some of the questions they had about the apparatus so as not to leave the lesson without purpose for the children. The questions were collected from the children and compiled for use in the analysis made on the seventh day of instruction (Appendix L).

Phase Two: Establishing Criteria for Poor Questioning Patterns

To continue the sequential development of the instruction toward the goal of constructing effectively-phrased questions, the investigator first required the methods students to establish criteria for identifying poorly phrased questions. These initial criteria were based on their observation of a science lesson with sixth-grade children.

This lesson was designed and cooperatively planned by the investigator and the teacher demonstrating the lesson. The questioning pattern used by the teacher of this lesson was designed to illustrate poorly-phrased questions, ineffective questioning techniques and their effect on the learning situation as evidenced in the types of responses given by the children (Appendix C).[1] The investigator identified the type of questioning pattern desired from his previously described analysis of classroom lessons. The children in this lesson were the same children that were observed in the lesson for effective questioning later in the instruction. The demonstration used as a basis for the lesson involved the same concepts as this later lesson. A concerted effort was made to account for all other variables except the phrasing of the questions and the ways in which the questions were sequenced and/or employed. For example the teacher made it a point to ask questions indiscriminately and to purposely ask such irrelevant questions as "What is the tin can made of?" The demonstration in this lesson was commonly called the "Monkey and the Hunter." To distinguish it from the apparatus used in the second lesson, the teacher referred to it as the "Whizzbang."

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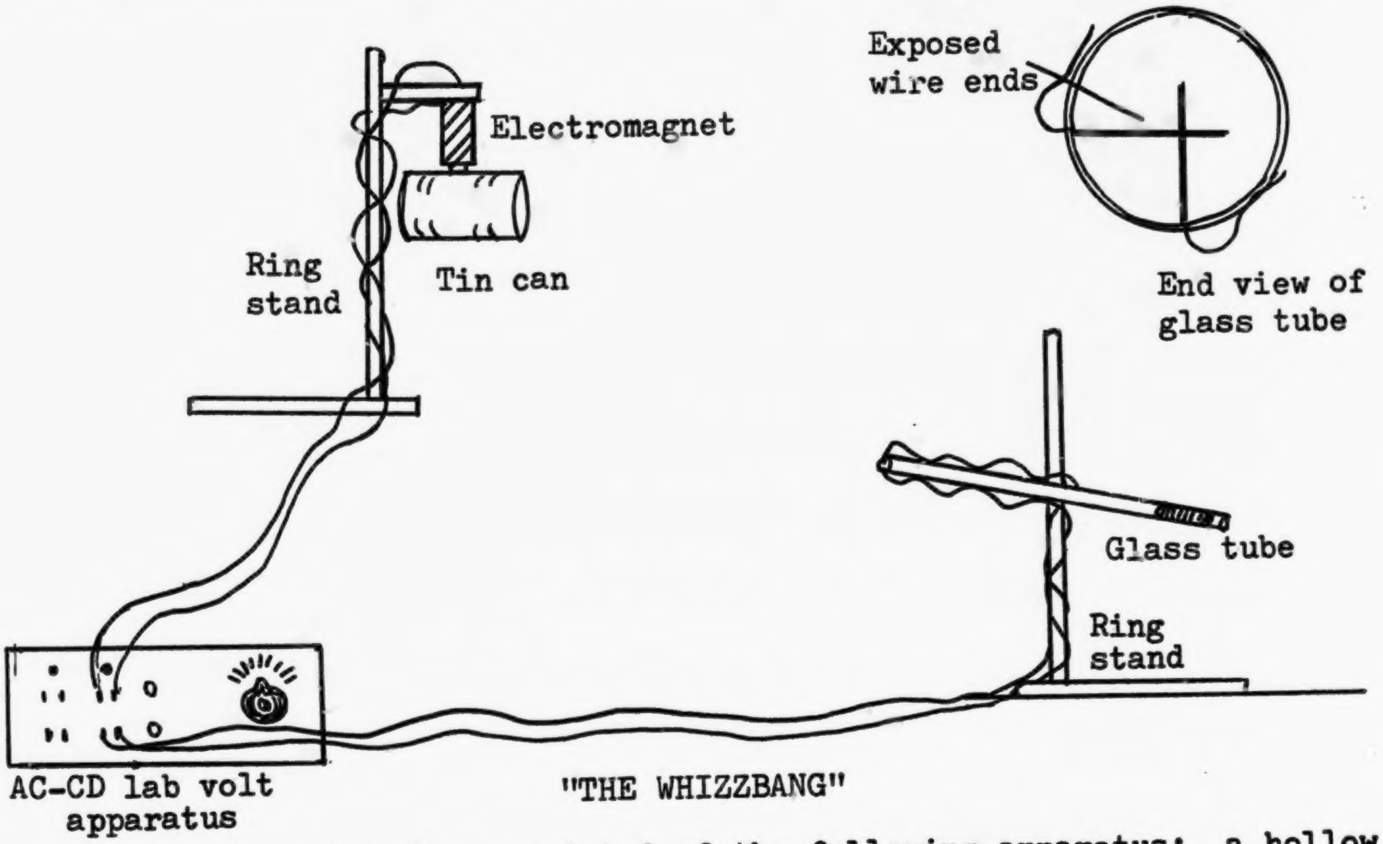
[1] DeBaggio, Mary Ann, "The Whizzbang," video-tape #5100, Indiana University, 1968.



"THE WHIZZBANG"

The demonstration consisted of the following apparatus: a hollow glass tube supported on a ringstand and placed on a table for ease in using. At one end of the glass tube the opposite ends of a direct current circuit were exposed and crossed over the opening of the tube. At the other end, a candle that fitted snuggly into the tube was placed just inside the tube. The wires from the opposite end of the tube lead to an A.C.-D.C. lab volt apparatus and in turn to an electromagnet that was also supported on a ringstand but placed in a position above and about 10 feet from the glass tube. When the electrical current was turned on, a tin can, with one end open, was placed on the electromagnet. The open end of the can was pointed toward the tube. The apparatus was put into action by blowing through the end of the glass tube that contained the candle. The candle shot out of the opposite end of the tube, broke the circuit and caused the electromagnet to release the can. If timed correctly, the candle would go into the can as it fell.

The teacher introduced the demonstration to the children with it not working as it should. She started the lesson by recalling what happened in a previous lesson, asking several questions that required recall. Then she asked a question about this apparatus and demonstrated how it works. The remainder of the lesson and the questions asked by the teacher related to the problem of getting the apparatus to work and the forces that were involved in its working (Appendix C--Dialogue).

Interaction Analysis

In their analysis of the first two video-tapes, the methods students used a part of an interaction-analysis scheme that deals with questions and responses.

This system of interaction analysis was used to quantify the qualitative aspects of verbal communication as they occur in the classroom. Basically it is a modification of the schemes constructed by Flanders and Amidon and Hunter as described in Chapter II. This system consists of four major categories, direct teacher influence, indirect teacher influence, pupil talk, and silence or confusion. Each of these categories, with the exception of the silence or confusion category, is divided into four sub-categories. These sub-categories are descriptive of the kind of verbal activity that may be going on at any given moment. Each of these mutually exclusive categories is keyed with a given number.

The procedure involves classifying each three-second communication or lack of communication as one of the prescribed numbered categories. Upon completion of a given lesson the tallies can be totaled and grouped for analysis. Because it was believed that a system of this type helps methods students to become more conscious of the importance of verbal patterns and their affect on learning, the methods students being instructed by the investigator were taught to use his interaction analysis scheme as a tool for analyzing their own teaching. Since the teaching of a lesson is an integral part of this methods course, the scheme was put into immediate practice.

During the two class periods prior to the implementation of this study the methods students received instruction in the use of the interaction-analysis system. Because of the familarity with this system, it served as a basis for the initial analysis of questioning patterns observed in lessons used in the study. Only four categories from the interaction analysis scheme relate directly to questioning.

Therefore, the first attempts at identifying types of questions and their related responses were based on the use of the following categories:

1. Narrow Questions:
    a. The teacher uses questions requiring one word or yes-no responses.
    b. Responses can be predicted.
    c. Usually call for a short answer or fact answer.

2. Broad Questions:
    a. These are open-ended, thought provoking questions; requiring expressions of opinion or feeling.
    b. Unpredictable and/or numerous responses are possible.

A. Predictable Responses:
    1. The pupil responds to the teacher's question with a short reply.
    2. Usually a one-word answer is the response to a narrow question.

B. Unpredictable Response:
    1. The pupil responds to a broad question with an unpredictable response expressing opinion, hypothesizing or explaining.

This initial means for identifying questions provided a tool for identifying and dealing with specific kinds of questions and responses as they were heard and observed in a video-taped lesson. It was expected that if the students could distinguish narrow questions from broad questions, they would be more adept at identifying criteria that distinguish poorly-phrased questions from effectively-phrased questions.

Phase Three: Establishing Criteria for Effective Questioning Patterns

The lesson used as a basis for analysis in this phase of the study was designed and planned for in the same way as the lesson used to characterize poorly-phrased questions and ineffective questioning techniques. The same children and teacher were involved in this lesson as were involved in the first lesson (Appendix E--Transcribed Dialogue).[2]

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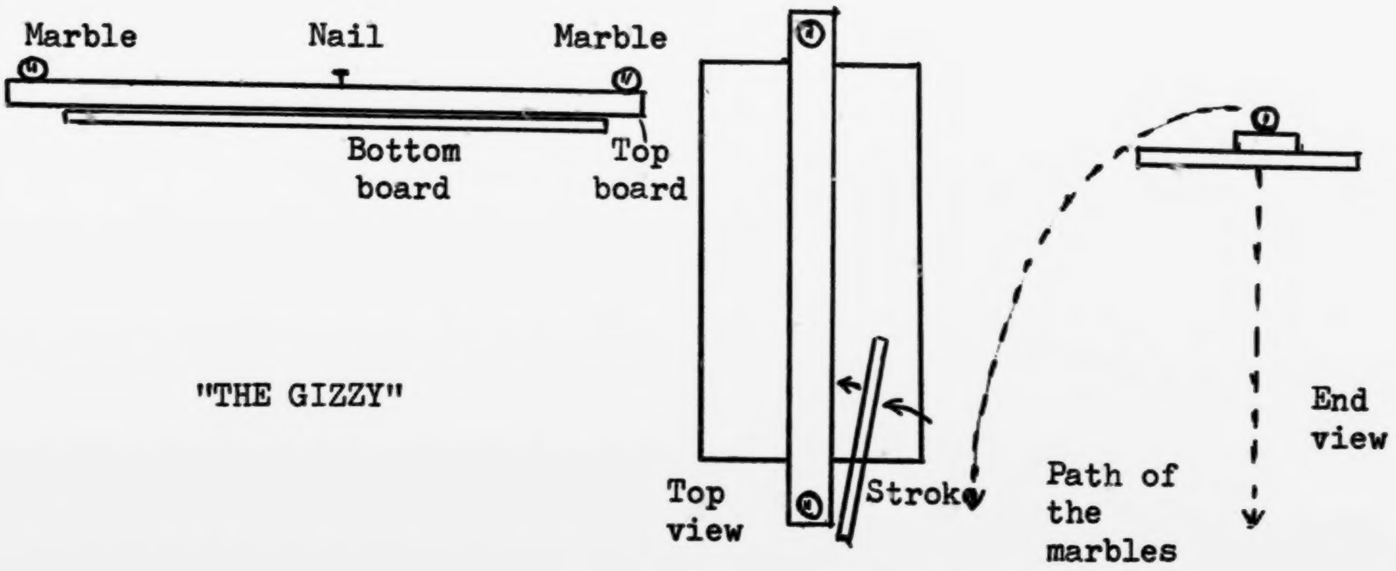
[2] DeBaggio, Mary Ann, "The Gizzy," video-tape #5054, Indiana University, 1968.

The apparatus used in the demonstration is different than that used in the first lesson but illustrates the same concepts. Again, a concerted effort was made to hold everything constant except the phrasing and means for employing the questions. For example, the teacher made it a point to more carefully follow a planned sequence for the questioning and at the same time make use of the ideas of the children. The technique of using a story to clarify the problem also was used. In addition, the teacher carefully selected more effectively-phrased questions throughout the lesson along with the use of appropriate clarifying questions to keep the children on the problem and to cause them to be more explicit in their responses. "What predictions can you make about what is going to happen to the marbles?" was a typical question (Appendix F-Criteria). To distinguish this apparatus from the apparatus used in the other lesson the teacher referred it as the "Gizzy."

Although the apparatus in the first demonstration was not complex, the apparatus used in this demonstration was simpler in construction. The apparatus consisted of a board three-quarters of an inch in thickness, approximately two feet long and ten inches wide. Fixed to this, on its top side, was another board slightly longer but only about two inches wide. The means of affixing the two boards was by one nail that was placed off-center in the top board. These materials comprised the basic components of the apparatus. These were then placed on top of a six-foot ladder.



"THE GIZZY"

The teacher conducted the demonstration by hitting one end of the top board with a sweeping stroke using a stick or 12-inch ruler. When this top board was struck, both marbles fell to the floor along different paths. The marble on the one end, because it was on the end of the board struck by the ruler or stick, followed an arced path while the marble on the opposite end followed a relatively straight path to the floor.

The questioning that took place throughout the lesson involved relating this observed phenomenon to the story and seeking to find out why this happens. Much of the questioning related to describing the apparatus, how and when the marbles hit the floor, and what variables could be introduced into the system. The lesson went on for 30 minutes, but the investigation continued for several days as a result of many new questions that arose from this investigation.

Phase Four: Establishing a System for Categorizing Questions

The methods students began phases two and three of the instruction by identifying questions with broad and narrow categories. They then proceeded with the analysis of a lesson by contrasting the number of broad questions with the number of narrow questions. This analysis provided a basis for establishing criteria for poorly-phrased and effectively-phrased questions. The investigator has shown in previous descriptions why narrow questions are poorly-phrased questions and broad questions are effectively-phrased questions (Appendix D and F). The investigator contends that this procedure of identifying broad and narrow questions, contrasting the two types of questions, noting the responses that result from their use, and establishing criteria for poorly-phrased and effectively-phrased questions from analysis based on these categories, provides a smooth transition into the use of the category system identified for use in this part of the study.

This system consists of four categories that serve as a basis for identifying various types of questions. The four categories or levels of questioning that comprise the system are based on the levels of cognition identified by Bloom, Englehart, Furst, and Hill and developed by Aschner and Gallagher as described in Chapter II (Appendix G). These four categories, cognitive-memory, convergent, divergent, and evaluative, serve primarily as a means for categorizing and distinguishing poorly-phrased questions from effectively-phrased questions. This system also permits thinking of questions in terms of a hierarchy of questioning. While using this system, one basic assumption is made for identifying the types of questions as they are described by the category system and related to the response given to these types of questions. This assumption is that a certain type of question yields the same kind of response. That is, divergent questions cause divergent responses. For example, a question like "What do you think would happen if the balls were a different size?" permits several possible responses from the children.

To facilitate understanding of the criteria for poorly-phrased or effectively-phrased questions as described by the category system, several examples of cognitive-memory, convergent, divergent, and evaluative types of questions were discussed with the emphasis on identifying the key words and ideas that distinguished one kind of question from another. This part of the instruction also required the methods students to classify a set of written questions according to the descriptions given in the category system. Several examples were also drawn from audio-taped lessons. The discussion of these examples made it clear that the use of the descriptions for cognitive-memory, convergent, divergent, and evaluative questions are not the only criteria for classifying different kinds of questions. However, these descriptions do permit a convenient means for qualifying the pattern of questioning and for distinguishing between poorly-phrased questions and effectively-phrased questions. During the instruction, emphasis was given to the key words, phrases or segments of questions that make the distinctions between the different types more obvious. For example the use of the phrases "What if . . . ?" and "What do you think . . . ?" are clues to diverent questions; "Can you . . . ?" and "Does it . . . ?" are hints to cognitive-memory questions; and "Why . . . ?" is a key to convergent questions.

Phase Five: "Brainstorming" Questions

The "brainstorming" technique that was used in the instruction for this study was designed as a means for improving the ability of the methods students to formulate and use effectively-phrased questions extemporaneously. Previously the investigator had found, from the analysis of the 55 lessons, that inexperienced teachers are unable to pursue ideas raised by children. The investigator also found an inability to use the responses given by the children for further questioning or an inability to question a child more extensively about his response so that he might think it out more thoroughly. The investigator attributed all of these inabilities to a causual factor--inability to extemporaneously formulate and use effective questions. The inability is even more pronounced in questioning patterns characterized by poorly-phrased questions. This "brainstorming" session, then, was designed to alleviate this problem, or at least, to make these subjects more conscious of the need for better preparation in this aspect of questioning. The instruction emphasized the importance first of an ability to listen to what the children have to say and then to utilize their responses in order to pursue the central problem more extensively. This requires skill in rephrasing questions so that children will see an event or problem from different vantage points. It also requires a thorough knowledge of the concepts and factual information related to the events observed in a demonstration or activity. It requires skill of the teacher to make best use of the children's observations of what takes place and of their responses to questions about the observed events.

The class period on "brainstorming," the sixth day, was based on a demonstration illustrated by a silent, single-concept film. This demonstration showed the following:

1. A cross made of tin is placed on the ring of a ring stand.
2. Then four fuels, match heads, sulfur, paper and wood are shown.
3. Next, each of these fuels is placed on one of the four ends of the tin cross.

4. Heat is then applied to the center of the cross with a propane burner.
5. Heat is transferred to each end of the cross by conduction.
6. When each fuel reaches its kindling temperature, it burns.
7. The match heads burn first followed by sulfur, paper, and wood.

The students viewed the film in its entirety first. Then while showing the film a second time, the investigator used a stop-action procedure in order to delay the film at pre-selected points so that the students could respond to the question What question would you ask at this point? Such stops were made in five places during the film.

After the second viewing, the methods students first agreed, as a group, on the concept illustrated by this demonstration. Then they were given the opportunity to ask, in writing, as many questions as they could within a limited period of time. In this "brainstorming" activity the emphasis was on quantity rather than the quality of the questions. The procedures that followed included selection of the best questions, construction of a composite list of the best questions suited to developing the concept decided on earlier, sequencing of these questions, and rephrasing these questions as divergent questions.

Phase Six: Determining Growth in Questioning Ability

During the last day of instruction, the seventh day, the procedure was to return to the lesson that was designed in the first day of instruction. Prior to this instructional period and immediately after the first instructional period, the investigator took the demonstration and the questioning pattern designed by the methods students into a fifth-grade classroom to conduct the lesson with the children. This part of the study was described in phase one. This lesson was video-taped for this seventh instructional period for analysis by the methods students.

Because the seventh day culminated the instruction on question phrasing, the primary focus was on analyzing the questioning pattern the methods students had designed themselves on the first day. This analysis was based on the criteria that had been established for poorly- and effectively-phrased questions as well as the criteria for effective and ineffective questioning techniques in earlier phases of the instruction. This analysis by the methods students also included an evaluation of the original questions according to the kinds of responses they elicited as viewed in the video-tape of the lesson taught to fifth grade children by the investigator. The methods students then attempted to rephrase these questions, seeking to design more divergent questions in light of their comprehension and application of the category system used in an earlier phase of the instruction. Once some of these questions were rephrased, the methods students were asked to hypothesize the probable responses that would result from their asking these rephrased questions. After a 10 minute session discussing these questions and their probable responses, the methods students were given the list of questions concerning the demonstration that had been asked by the children in the three fifth-grade classes referred to previously. The remainder of this instructional period was devoted to comparing the methods students' questions to the children's interests, as represented by the questions they had asked about the demonstration.

Operational Definitions

"Question"--any utterance by the teacher that implies an interrogative statement.

"Questioning technique"--refers to the way in which a question or set of questions is employed by the teacher in a lesson.

"Questioning pattern"--used to identify the character of a set of questions and techniques that comprise a lesson. Therefore, this is a broad term that refers to both the phrasing and technique.

"Phrasing"--a term that refers to a question in terms of its word order, grammatical structure, and use of key words.

"Prospective elementary teachers"--used interchangeably with students, subjects, and methods students to refer to the two groups of elementary education majors enrolled at a large midwestern university.

"Inquiry"--an autonomous activity stimulated by appropriate questioning resulting in development of different levels of cognitive skills.

"Elementary school science"--a general term referring to all activities normally carried out in the science phase of the elementary school program.

"Narrow questions"--those questions requiring short memory responses that include factual or yes or no answers.

"Broad questions"--thought provoking questions that lead to hypothesizing, predicting, or expressions of opinions or feeling and permit numerous unpredictable responses.

"Poorly-phrased questions"--questions that permit only very narrow responses including questions that lack structure because they are sentence fragments, statements implied as questions or one word questions.

Poorly-phrased questions are also identified by their function as questions that elicit low level memory responses. Responses are usually predictable (Appendix D).

"Effectiveness"--the degree to which a teacher produces effects on the pupil measured in growth, gains, development, learning, and achievement.

"Effective questions"--questions that are phrased so that the intent of the question is clear to the respondents.

"Effectively-phrased questions"--questions that are clear and concise with a definite word order and grammatical structure. These questions also are identified with a function that serves to elicit responses that are imaginative and creative and require synthesizing knowledge into new patterns. Responses to these questions are usually unpredictable (Appendix F).

"Ineffective questioning technique"--a method of employing questions that hinders development of clear thought processes or impairs the problem-solving situation (Appendix D).

"Effective questioning techniques"--a method of employing questions that utilizes and develops the thinking of children and enables them to make significant associations in order to complete the problem solving situation (Appendix F).

"Predictable responses"--a term applied to responses given to narrow questions. These are responses that can be anticipated because of the way a question is phrased.

"Unpredictable responses"--a term applied to responses that are not prejudged by the phrasing of a question. They are usually responses to questions that are broad or phrased so that many student ideas are considered.

"Clarifying questions"--a term applied to narrow questions which are used to cause a child to qualify his response to clarify a problem as it was presented in an original question, to yield data, to qualify a response or to extend considerations to other aspects (Appendix F).

"Cognitive-memory questions"--typically narrow or poorly phrased questions that cause predictable responses. This is the lowest level of questioning in the hierarchy of questioning because questions in this category demand recall responses (Appendix G).

"Convergent questions"--questions to which there is one best answer. These are questions that require integrating ideas, relating explanations in the respondent's own words and are used often to cause the student to clarify his response. The key word is often "why" (Appendix G).

"Divergent questions"--a term used to describe effectively-phrased questions that call for responses that are creative and imaginative and relate ideas into new patterns of thought. A key phrase is "What if . . . ?" (Appendix G).

"Evaluative questions"--a term applied to narrow or broad questions that call for responses that involve matters of judgment, value, and/or opinions but not of choice. This is considered the highest level of questioning because it may involve all the levels of cognition. Responses to these questions require applying criteria to some evidence to take a self-selected position.

The Method of Instruction

The model for the instruction was arranged in the following sequence:

1. The construction of a questioning pattern based on initial questioning ability to design a fifth-grade science lesson for the purpose of analyzing gains in questioning ability at the end of the instructional period.

2. The analysis of a video-taped lesson for the purpose of identifying poorly-phrased questions and ineffective questioning techniques.

3. The analysis of a video-taped lesson for the purpose of identifying criteria for effectively-phrased questions and effective questioning techniques.

4. The introduction to and use of a system of four categories for the purpose of classifying questions, systematizing the information gained about questions, and analyzing questions more critically in relation to their designed functions.

5. The "brainstorming" of questions for the purpose of developing skill in constructing questions extemporaneously.

6. The analysis of a previously designed questioning pattern as it was used in a classroom for the purpose of rephrasing and reconstructing questions for a more purposeful function and the application of knowledge gained about questioning in the interim phases of instruction.

7. The analysis of children's questions to pass judgment on the effectiveness of questions designed for a given lesson situation.

Day One

The investigator began the instruction on the first day with the following explanation:

> As a result of some of your previous experiences with certain aspects of lesson planning, you have realized that the kinds of questions that a teacher asks during a lesson are most important for achieving the objective of the lesson and for stimulating interest in the lesson activity by the children. Because many teachers lack the ability to formulate and use effective questions during lessons in science, as well as other areas of the curriculum, we will be focusing our attention on this problem during the next few sessions. During these sessions you will be asked to construct questions for different purposes and to analyze and evaluate lessons conducted by teachers. The latter will be based on the questions that have been used as well as the questioning techniques that have been employed by the teacher in these lessons. Therefore, it will be important for you to direct all your attention to these aspects of the teaching act while viewing and analyzing a lesson.

The investigator began this first phase of the instruction by explaining to the subjects (the methods students) that they would begin the instruction on questioning by designing a questioning pattern based on the observations they have made of a demonstration conducted by the investigator. It was further explained that this demonstration, with the questioning pattern designed by them as a group, would be used in a fifth-grade class (ten-year-olds) as the basis for a lesson with these children. At this point, the methods students were also given the following performance objective for this lesson: Upon observing this demonstration the child shall be able to verbally describe the observations he has made on how the apparatus works and verbally state reasons why he thinks these things happen.

The investigator began the demonstration with the following description of the apparatus used in the demonstration:

> The apparatus consists of two boards exactly the same length hinged together on one end. The top board has a cup fastened down to its top side and a depression curved out on this same side, very close to the unhinged end. To make ready for use in the demonstration a twelve inch ruler is placed in the notches provided on the two boards. Next, a metal ball is placed in the depression in the top board.

After this description was given, the investigator conducted the demonstration by first giving the following directions to the methods students:

> Now that you know the purpose for this demonstration, please do the following carefully:
>
> 1. Observe everything that happens in the demonstration as I do it three times.
> 2. Now note the observations you made and recall the objective of the lesson in which this demonstration will be used. Then write out all the questions you would ask of the children as the teacher using this demonstration in a class of fifth-grade children.
> 3. After you have written out your questions check what you consider to be the five best questions.
> 4. Once you have selected your five best questions, place them in a sequence that you consider appropriate by numbering them one through five.

The first 15 minutes of this class period were given to this part of the instruction with 10 minutes allowed for the writing of the questions.

In the next phase of the instruction during the first day, the methods students, as a group, compiled a composite list of 25 questions that they had identified as good questions from their written list. Because it was not appropriate on the basis of time to list all of each individual's five best questions, they were asked to select and contribute their best question. Duplications did occur, so first second and third choices were made. A complete list was compiled by the investigator from the written lists that were turned in by the students. From the list of 25 questions, which were recorded on an overhead transparency, the group selected the 15 best questions to be asked by a teacher using this demonstration in a fifth-grade class. A brief discussion was permitted to consider criteria for selection of the best questions. The selection of the questions was finally made on the basis of those questions that are most relevant to the concept illustrated in the demonstration and the objective of the lesson. The relevancy of a question was to be considered in terms of the following criteria:

1. It clarifies the concept to establish the problem.
2. It leads to further experimentation to more fully develop the concept.
3. It asks for information that is needed to solve the problem.
4. It satisfies other criteria agreed upon by the methods students.

When the group had agreed on the questions to be used in the lesson, they were then asked to decide on the most logical sequence for asking these questions. The decision for sequencing was to be based primarily on placing questions in an order by which the concept could be developed most meaningfully. A great deal of disagreement did occur as to how the questions should be sequenced. It was evident that one group of prospective teachers had greater difficulty agreeing on a sequence. In fact, agreement was never reached even after a second attempt at a later date. The investigator suspected that the reason for greater disagreement arose from the fact that these students had had some exposure to the classroom and therefore had different notions about how the lesson might be initiated. Agreement was reached on the general trend of the lesson with broad areas identified and alternative questions suggested. It was evident that this group was more conscious of the responses that might be given by the children. In both groups the attempt to establish a questioning sequence resulted in a thorough and critical discussion of the wording of questions. Several questions were rephrased and some problems of phraseology and methodology were identified. Nevertheless, it was evident with both groups that they were still unaware of many of the problems that might occur as a result of phrasing a question a particular way or with using a set of questions in a particular manner. It also became evident, but not until a later date, that lack of a complete understanding of the demonstration and its related concepts prevented construction of good questions. This was a problem that was very appropriate to illustrating the need for understanding of the content dealt with by a teacher during the teaching act. Since disagreement concerning the aspects of best questions and sequence did occur, the lists of questions compiled by individuals were collected for use during the analysis of the lesson on the seventh day. At this time, the questions were returned to the methods students so that they could analyze both the questioning pattern designed by the group and the pattern that they as individuals had suggested.

Day Two:

The instruction on questioning during the second day was based on the analysis of a lesson taught by an elementary school teacher working with a class of sixth-grade children (eleven-year-olds). The purpose of this analysis was to identify those criteria that characterize a poorly-phrased question. The analysis of this video-taped lesson was also for the purpose of identifying those criteria that characterize ineffective questioning techniques (Appendix D).

First, the methods students observed the 15-minute video-tape of this lesson of the teacher working with a class of sixth-grade children. This lesson, as designed by the investigator and the teacher, contains several examples of both poorly-phrased questions and ineffective questioning techniques. The methods students were introduced to this lesson with the following instructions:

> You are about to view a video-tape of a teacher working with a class of eleven-year-olds. In this lesson the teacher is demonstrating a piece of apparatus that released two projectiles that interact with one another but that are caused to take different paths. The purpose of this demonstration is to introduce the problem of how gravity influences projectiles and falling objects. This lesson is a part of a unit of study on force and motion that was followed by several related investigations. The lesson is based on the observations and descriptions the teacher and children make of this piece of apparatus. While viewing this lesson you should try to note
>
> 1. The questions asked by the teacher
> 2. The nature of the activity accompanying a question
> 3. The number and kind of responses given by the children.
>
> Be prepared to discuss this lesson and evaluate its effectiveness on the basis of the quality of the questions asked and their related responses.

To facilitate a better understanding of the demonstration used by the teacher in the taped lesson the investigator brought the materials into the classroom and demonstrated how they worked and described the concepts that were involved. To provide a clear understanding of the demonstration questions were permitted and discussed. Several questions about the materials, concepts shown by the materials, and the objective of the lesson were discussed.

After viewing this lesson, the investigator and the methods students discussed the lesson in terms of its effectiveness or ineffectiveness as a complete lesson. The investigator encouraged comments that focused on the nature of the questioning and its effect on the responses given by the children as observed in the lesson. The reactions, comments, and preliminary criteria given by the methods students were recorded on audio-tape and the chalkboard, placed on ditto copy for future reference and distributed to the students during the next session. This discussion continued for approximately 15 minutes. The investigator anticipated that the analysis of the questioning pattern considered in this first viewing would be on a very general basis, lacking comments that point to specific aspects of proper phrasing of questions. The investigator also expected the analysis of the lesson to be typical to that made by an observer who has had no prior instruction in questioning. These expectations were fulfilled in this discussion. There was a noticeable difference in the two groups in their analysis of the questioning pattern. The one methods class was more critical in its analysis of questions. The investigator suspects that prior experience with simulation materials at the beginning of the term contributed to this more fastidious approach to analyzing the illustrated questioning pattern. Despite this, it was apparent that there was a need for focusing on the causal factors. At this point, the investigator identified the need for closer examination of the way the questions are worded and for noting more carefully the kinds of responses that resulted from asking the questions as they were so phrased.

The methods students were then introduced to the second viewing of this same lesson with the following instruction:

> 1. In a previous class session you learned to use an interaction-analysis scheme for recording verbal interaction in a classroom. As a part of this scheme, you recorded broad and narrow questions along with predictable and unpredictable responses. Record your observations according to the following numerical-letter scheme:
>
>   1. Indicates narrow questions
>   2. Indicates broad questions
>   A. Indicates predictable responses
>   B. Indicates unpredictable responses
>
> 2. Upon the completion of the lesson, count the number of tabulations for each category.
>
> 3. After you have recorded your results during this second viewing, you should be prepared to discuss the pattern of questioning in a more detailed way. Refer to the descriptions in the interaction-analysis scheme given to you earlier.

The tabulations the students had made for the two types of questions and their related responses along with a transcribed copy of the dialogue of the lesson were used for further analysis of the lesson by the methods students in preparation for the third day.

Using the results of their tabulations and the dialogue, they were instructed to identify, in writing, four criteria that distinguish poor questions from good questions. They were also asked to identify in writing four criteria that distinguish effective questioning techniques from ineffective questioning techniques. At this point the investigator made the following distinction between questions and questioning techniques: a questioning technique can be identified according to the way in which a question is used; while the evaluation of a question deals primarily with the particular way it is phrased and the quality of resulting responses it elicited. The investigator sought to guide the students toward understanding that both the question phrasing and the questioning techniques may influence the responses. The students were directed to look for both factors in their analyses.

This procedure was used by the investigator as the initial means for categorizing questions according to the way they are phrased. This plan also permitted dealing with specific kinds of questions and determining the influence of the phrasing of a question on the kinds of responses that result from asking questions phrased in a particular way. For example, one of the first things that the investigator expected the methods students to detect, as they did, is that a question like "Do you think it makes a difference if I keep the apparatus set up this way?" usually provides only a limited response of "Yes" or "No." On the other hand, a question like "If I keep the apparatus set up this way, what predictions can you make about what is going to happen?" permits several possible responses.

At this point, too, the investigator asked the methods students to compare the preliminary criteria they had established during the first viewing with the criteria they established after the second viewing. This second viewing included formulating an analysis based on the tabulations of types of questions and responses and the dialogue of the lesson. The methods students were asked to write a revision of their original criteria which determined poor questions and ineffective techniques and be prepared to discuss any changes they had made as a result of the analysis.

The following instructions were given for this and for all succeeding written assignments:

> 1. No one is to spend more than one hour on any written assignment that is given during the instruction on questioning.
>
> 2. All work is to be done individually. This will be important to gain variety in the types of work that are produced. Differences in answers and approaches to written work will be more important than commonality.

Day Three

The instruction for the third day began with a listing of the criteria for poorly-phrased questions and ineffective questioning techniques, as identified by the methods students in their analysis of the lesson observed the second day. The discussion for this part of the instruction centered around the reasons for selecting these criteria. After approximately a 15 minute discussion of these criteria, the investigator enumerated criteria for distinguishing poorly-phrased questions and ineffective questioning techniques as determined by his analysis of 55 lessons, described in detail in an earlier part of the description of the procedures (Appendix D). These two sets of criteria were surprisingly similar.

Criteria for poor questions identified by methods students:

1. "extensive verbalization"
2. "too many unfamiliar terms"
3. "does not involve critical thinking"
4. "do not lead to further ideas"
5. "irrelevant"
6. "confusing wording of question"
7. "yes-no questions"
8. "used terms new to students"
9. "not clear to children"

Criteria for poor technique identified by methods students:

1. "too many questions at one time"
2. "not geared for level"
3. "not related to past learning"
4. "questions seek answers that are too definite"
5. "includes answer in question"
6. "no logical order"
7. "unable to determine objective"
8. "too many questions in a row"
9. "no time for students' ideas"

This list of criteria for poorly-phrased questions and ineffective questioning techniques were then recorded and duplicated for reference in the analyses of lessons that follow.

During the latter half of this instructional period, the methods students were introduced to a second lesson that was also observed on video-tape. This lesson, like the lesson used on the second day that emphasized poorly-phrased questions and ineffective questioning techniques, had been purposefully designed by the investigator and teacher of the lesson to characterize a lesson using effectively-phrased questions and effective questioning techniques as described earlier (Appendix E). The same teacher and children were involved in this lesson, and the demonstration used as a basis for the lesson was similar to that used in the lesson observed on the second day. This lesson, too, is described in detail in the preceding section of the study. The methods students were introduced to this lesson with the following instructions:

> You are about to view a second lesson involving the same teacher and the same children working with a demonstration that is very similar to that which you observed in the first lesson. Using the same scheme for identifying the general types of

> questions that you used in the previous lesson, that is broad and narrow, and types of responses, predictable and unpredictable, tabulate the kinds of questions and their related responses during your observation of this video-taped lesson. Again, your tabulated results will serve as a basis for analyzing the effectiveness of the questioning pattern used in the lesson.

To provide continuity and to give more purpose to the analysis of this lesson, the methods students were given a written assignment to prepare for the next period of instruction. This assignment consisted of a set of eight questions designed to cause the student to focus on specific aspects of the questioning in this lesson. To facilitate the answering of these questions, the methods students were given a complete transcribed dialogue of the lesson observed on video-tape. They also used their tabulations for the general types of questions and responses as they were used in the previous analysis after the second day. The use of these categories, broad and narrow questions and predictable and unpredictable responses, permitted a common basis for comparing the questioning patterns used in the two lessons. It also permitted an objective means for identifying the general trend of the questioning pattern. At this point, the student should have been able to identify a greater number of broad questions and unpredictable responses.

In preparation for the instruction on the fourth day, the methods students were asked to prepare a written evaluation of the questioning pattern, characterized by the phrasing of the questions and questioning techniques used in this lesson by answering the following questions:

1. Which questions did you consider most effective?
2. Why did you consider them more effective?
3. What questioning techniques in this lesson did you consider most effective?

4. Which kind(s) of question(s) got the greatest number of responses from the children?
5. What evidence can you give that the teacher was taking clues from the children in her questioning?
6. What evidence can you give that the teacher employed techniques which kept the lesson moving?
7. What are some results that gave evidence to the fact that a poor question had been asked?
8. How might the questioning in this lesson have been improved?

Day Four

The first part of this period of instruction was based on a discussion of the questioning pattern employed in the second lesson observed on video-tape on the third day using the eight questions given for the written assignment. The purpose of this discussion was to identify more refined criteria for distinguishing effectively-phrased questions from poorly-phrased questions and effective questioning techniques from ineffective questioning techniques. Emphasis was placed on contrasting these two questioning patterns. The methods students had the dialogues for both lessons to use when completing the written assignment. They also had a copy of the criteria that had been previously established for poorly-phrased questions and ineffective questioning techniques.

During this discussion, distinctions were made between narrowly-phrased questions that call for specific answers or yes-no responses and questions that permit divergent responses. Similar distinctions were made for questions that were relevant to the central problem of the lesson and those that were irrelevant. The criteria previously established for relevancy were applied. The same consideration was given to the technique of asking several questions without permitting a response as opposed to the more effective technique of rephrasing the same question in different ways before permitting a response.

To conclude this discussion, the methods students were asked to enumerate criteria for effectively-phrased questions. These criteria were recorded as they were discussed. When the students had identified their criteria for effectively-phrased questions and effective questioning techniques, the investigator added those criteria he had determined from analysis of the 55 lessons, as identified previously. These criteria were then duplicated and given to the students for analysis of lessons to follow.

Once these criteria had been established, the methods students were introduced to the second viewing of the lesson designed to demonstrate the use of effectively-phrased questions and effective questioning techniques (Appendix C) with the following instruction:

> Now that you have established criteria for both poor and effective questioning patterns,
>
> 1. Reanalyze this lesson that you have previously viewed.
> 2. Note specific examples of poorly-phrased questions and effectively-phrased questions by checking them on your copy of the dialogue.
> 3. Also look for evidence of the questions' influence on the responses given by the children.
> 4. Try to determine if your criteria still apply in this lesson.

These identifications were based on the clarifications the methods students made in their written assignment and the criteria established in the group discussion preceding this second viewing. With this analysis as a background, it was the belief of the investigator that the students would be able to view the lesson with more critical scrutiny. The refining of the criteria for the two types of questioning patterns served as a basis for the analysis of lessons presented in later phases of the instruction and provided an appropriate transition into the use of the four-category system identified by the investigator for classifying types of questions that were introduced in the next phase of the instruction. It was also used as a means for describing types of questions during the remainder of the instruction. At this point, the investigator expected the criteria established by the methods students during the last two class periods for poor and effective questioning to be very similar to the descriptions given for each of the four criteria in the category system. The match between the criteria established by the students from their analysis of the observed lessons and those established for the four categories was surprisingly close. The investigator took the opportunity to capitalize on this obvious match to illustrate how these questions could be thought of in terms of these cognitive levels. It also permitted the opportunity to illustrate how types of questions could be considered in relation to a hierarchy because of their intended purpose determined by the method of phrasing the question.

At the conclusion of this period of instruction the methods students were given a copy of the category system to examine carefully prior to the next period of instruction.

Day Five

The major portion of this class period was devoted to introducing the category system to the methods students as it has been described earlier. In this introduction several examples of cognitive-memory, convergent, divergent, and evaluative questions were given as they had appeared in previous lessons. A concerted effort was made by the investigator to relate examples of these kinds of questions to the established criteria for poor and effective questioning patterns. The instruction during this time included opportunity to identify several examples of questions for each of the four categories in this system. Much attention was given to identifying key words and phrases that characterize each kind of question. The instruction in the category system also required the students to write a few examples of each kind of question.

In order to immediately apply what they had learned from the introductions to the category system, the methods students viewed a 15 minute video-tape of a lesson conducted by a student teacher working with a class of first-grade children (six-year-olds). Prior to viewing this lesson they were given a transcribed dialogue of the lesson and the following instructions:

> You are about to view a lesson of a student teacher working with a group of first-grade children. In this lesson the teacher has set the development of the skill of observation as her major objective. The teacher and the children in this lesson make observations of the goldfish and relate these observations to other animals they have observed.
>
> 1. As you view this lesson, follow its progress by referring to the written dialogue of the lesson you have before you.

2. Using appropriate abbreviations, identify each of the questions asked by the teacher in this lesson with one of the four categories (cognitive-memory, convergent, divergent and evaluative as they have been defined previously) by noting beside the question the type in which it best fits.

The transcribed dialogue of this lesson and the accompanying written activity are described in section D of the Appendix.

The last few minutes of this class period were used to conduct a brief discussion of the video-taped lesson and to explain the written assignment for the next class period. The focus of the discussion was on identifying the general trend of the questioning pattern used in this lesson. The written assignment described a performance objective of the lesson and gave a brief description of the learning situation. The assignment also consisted of a partial dialogue of the lesson and required the student to state new questions or rephrase the questions for specific purposes. These purposes include

1. An effectively-phrased question for initiating the lesson
2. Questions phrased so that they are relevant to the objective
3. Questions that are rephrased in relation to the responses given by the children
4. The teacher's questions rephrased so that they are characteristic of the different levels of questioning described in the category system.

It was obvious to the observer of this lesson that the kind of responses given by the children are directly influenced by the phrasing of the question used by the teacher.

Day Six

The instruction on the sixth day was initiated with a discussion of the questioning pattern used in the lesson observed during the class period on the fifth day. The written assignment given at the end of the period on the fifth day served as a basis for this discussion. The purpose of the written activity was to provide practice in rephrasing questions for different levels of questioning as defined by the category system. This activity was designed not only to enhance the skill of recognizing divergent questions by the way they are phrased but also to establish a purpose for divergent questions. The ease with which students related the criteria for poorly-phrased questions, discussed in previous analyses, to the characteristics of cognitive-memory questions and the criteria for effectively-phrased questions to the divergent category was very evident. The association was made through several examples of questions used in the lesson. In addition poor questioning was an obvious deterrent to the effectiveness of this observed lesson. The discussion served to strengthen the desired outcome by permitting the students to give responses that they could expect from children as a result of phrasing a question for divergent thinking by permitting students to ask the questions of one another and to give possible responses. The investigator took this opportunity to stress the relationship between the phrasing of the questions and the nature of the resulting response.

For the second half of this period of instruction, the technique of "brainstorming" questions was used with the methods students. The investigator showed a silent, single concept film, as described previously. This film was shown twice. A stop-action procedure was used during the second viewing. The investigator stopped the film five times during the second viewing and asked the methods students to phrase a certain kind of question as defined by the category system for each of these stops. Upon completion of the second viewing, the methods students were given the following instructions:

> 1. Now write as many questions as you can think of that you might ask children about this demonstration. In this "brainstorming" procedure the emphasis is on quantity not quality.
>
> 2. Once you have listed as many questions as you can think of, quickly number them in the order that you would ask them.
>   a. Select what you consider to be your five best questions.
>   b. Now rephrase these as divergent questions if they are not already in that form.

When the methods students had completed this activity, the investigator asked them to contribute to a composite list of questions by giving the divergent questions they selected as their best. From this composite list the methods students and investigator selected a set of questions that would be most effective for developing an understanding of the concept as it was illustrated in the film. Rephrasing of these questions was done if necessary. The use of clarifying questions was also discussed since the methods students found it difficult to construct an effective questioning pattern using only divergent questions. The investigator also expected that some discussion would center around the decision concerning the purpose that the questioning pattern should serve. This did occur but was limited in extent. The investigator sought to encourage the methods students to hypothesize probable responses to some of the rephrased questions, explain their reasons for phrasing the questions the way they did, and then decide if the purpose of the questioning pattern should be to lead the students to further experimentation or to understand the concept as it is illustrated in the film. In addition, the investigator expected the methods students to see a relationship between the way the question is phrased and the purpose it serves. The investigator also expected them to have a better realization of the variety of questioning patterns that could be used with the same lesson depending on the purpose of the questions in terms of the objective of the lesson. Within the scope of a few examples and the time available these expectations were realized.

Day Seven

The investigator initiated the instruction of this day by recalling what had been done on the first day of instruction. At this time he returned the lists of questions that the students had compiled. The investigator then described what was done with the demonstration and questioning pattern they had designed during the first day. The methods students were introduced to the video-tape of the lesson conducted by the investigator in a fifth-grade classroom with the following instructions:

> You are about to see a video-tape of a lesson using the demonstration you observed during the first class on questioning now based on the questioning pattern you as a group designed then.
>
> 1. As you view this video-tape, follow the dialogue of the lesson.
>
> 2. Note beside each question what kind of question it is, using the four types from the category system.
>
> 3. Also note the kinds of responses that were given by the children.
>
> 4. And be prepared to discuss the effectiveness of this questioning pattern and to rephrase some of the questions after the lesson is finished.

After the tape had been viewed once, the methods students and the investigator discussed the effectiveness of this questioning pattern on the basis of the criteria established for poor and effective question phrasing used earlier as well as the criteria for effective and ineffective questioning techniques.

Then the methods students were asked to rephrase some of the questions used in this lesson into more divergent questions. Once several questions had been rephrased, the investigator asked that they explain their reasons for phrasing the questions in this way. Some reasons were: (1) "By not using the word, 'can' to start a question prevents a yes or no answer." (2) "By asking the question this way, 'What predictions can you . . . ?' is better because more can respond with ideas." (3) "Well, by changing the question that way, I don't give the answer a way?" (4) "The way we had it worded made the child skip much of the information that would help them solve the problem." (5) "The question is too general."

For the last part of this period the instruction focused on comparing the questions that the methods students had constructed with those that the fifth-grade children had asked about the same demonstration. A list of the questions asked by the children (Appendix L) in the three fifth-grade classes was given to the methods students while the rephrased list constructed by the methods students was recorded on a transparency projected for their viewing.

During this last discussion session, the primary concern was with evaluating the rephrased questions on the basis of how well they matched the interests and concerns of the children and how well these questions would permit the children to explore their own ideas as related to what was shown by the demonstration. The methods students were asked to consider such questions as these: What evidence is there that the rephrased questions lead the children more effectively toward seeking solutions to the problem than did the original questions? What evidence is there that the rephrased questions more readily permit the children to seek solutions to those things that were problems for them than the original questions? What other considerations must be taken into account when phrasing questions for a demonstration of this type? This discussion also included comments and evaluation of the questions raised by the children. It was the investigator's subjective judgment that the reactions of the methods students' discussion of the children's questions reflected on enlightment with respect to the sophistication of their questions and the depth of their interest. The need for depth understanding of the content and use of more divergent questions appeared to take on more purpose for the methods students.

As a result of this analysis it was hypothesized that the methods students would completely revise their original questioning pattern as designed by them on the first day. Although revisions were not extensive, a greater awareness of poorly-phrased questions and ineffective questioning techniques was evident in the discussion of the lesson. It was obvious that the investigator could not expect the methods students as a group to agree on one questioning pattern that is most suitable. Therefore, the purpose of asking them to keep a record of their own questioning pattern from the first day became more meaningful at this point. This permitted them to analyze the lesson both in terms of what they have designed for a questioning pattern as a group and as individuals. This procedure also provided the opportunity for each student to see more than one suitable approach for designing questions for this demonstration when used as a basis for a science lesson in a fifth-grade class. At this point the investigator drew attention to the fact that changing the objective of the lesson changes the purpose of the questioning and contributes to a variety of questioning patterns.

Follow-up Procedures

Post-Test Measure (Appendix H)

On the last day of the study a post-measure was administered using the same procedure described for the pre-measure. The same instructions were given to the students. The lesson used for this post-test was slightly different from that used in the pre-test but, it was designed for the same purpose and therefore had a similar objective. The children involved and the teacher conducting the lesson were not the same as those in the pre-test. The same amount of time was allowed for writing as was in the pre-test. When the students had completed the writing, the questions were collected and tabulated along with the pre-test questions for later evaluation.

Student Assessment of the Instruction-Questionnaire (Appendix I)

Approximately two weeks after the instruction in questioning, the subjects involved in the study were given a questionnaire. This questionnaire was designed to allow the students to assess their own progress in questioning and to judge the effectiveness of the various segments of the instruction. Therefore, the questionnaire asked for these three responses:

1. Assessment of student's own progress in questioning
2. Ranking segments of instruction by order of effectiveness
3. Suggested changes in the instructional program.

This questionnaire is shown in Appendix I and the results are described and analyzed in Chapter IV.

Evaluation of Questions by Judges

When the questions written by all of the subjects on both the pre-test and post-test had been tabulated, the investigator decided to use only the questions written for item number four on the pre-test and items two and three on the post-test. These items were selected because they contained exactly the same criteria for writing questions and provided the largest number of written questions by the subjects. A total of 384 questions were written for these items on the post-test and 284 on the pre-test. In order to maintain the context in which the questions were written, they were identified as sets. In other words, one set of questions was written by one individual.

Next, the investigator, using the table of random numbers, made a random selection of 15 sets from the pre-test and 15 sets from the post-test. These 30 sets of questions or 30 individuals, as represented by the questions they had written, were randomly assigned to an order. These ordered sets of questions were then printed and comprised the instrument that was submitted to the panel of judges for evaluation.

The panel of seven judges consisted of five science educators from different parts of the country enrolled in a doctoral program at Indiana University. These judges had had teaching experience at both the elementary and secondary levels. The other two members of the panel were elementary classroom teachers of science and mathematics (Appendix A).

The panel of judges was assembled for one three and one-half hour session. This session had two purposes: (1) to give the judges instruction in the criteria and category system and (2) to evaluate the sample sets of questions. The first hour and one half was devoted to instruction and the last two hours to evaluation of the questions. During the instructional period the following procedures were used:

1. A brief verbal description of the study was given describing the purpose and procedures used.

2. A description of the established criteria for evaluating questions according to their phraseology and function was given with the discussion centering on several examples from the dialogues and criteria used in the study (Appendix C, D, E, and F).

3. An introduction to the category system was made by describing the relationship to the criteria for poorly- and effectively-phrased questions (Appendix G).

4. Instructions for evaluating questions, as they are given in the instrument were reviewed (Appendix J).

Examples not used in the instrument were used to illustrate questionable points in the evaluation procedure. When the judges had completed the evaluations, the results were tabulated for analysis in Chapter IV.

Interview with Teacher

As a follow-up procedure the teacher who conducted the video-taped lessons used in the instruction was interviewed (Appendix K) to identify changes she noticed with the children and herself as a result of using the two different questioning patterns.

Also as a further follow-up procedure, several audio-tapes were made by the investigator of the students involved in the study while they were teaching a science lesson. Because these observations appeared to open up an entirely new investigation which is not within the scope of the present study, the investigator did not attempt to evaluate the competency that these prospective teachers have for using effective questions in the classroom. It is the feeling of the investigator that his observations of these lessons have implications for continued study of methods that will determine and increase the capacity of prospective teachers to use more effective questions in the classroom.

CHAPTER IV

ANALYSIS OF DATA

This chapter will present the results of the study. The capacity for recognizing and constructing effectively-phrased questions, identified with divergent questions, for elementary school science and other related data concerning a select group of prospective elementary teachers were determined. These data are presented in three sections as follows:

1. Analysis of evaluation by the panel of judges and the investigator to establish interjudge reliability.

2. Improvement in capacity to construct effectively-phrased questions as represented by change in the proportion of cognitive-memory questions to divergent questions.

3. Analysis of student assessment of the instructional program as represented in the results of a questionnaire.

The data as presented seeks to resolve the central problem of the study. This problem, as it was presented in Chapter I, follows: If, through a method of instruction that employs analysis of video-taped classroom science lessons, prospective elementary teachers can show a significant improvement in their capacity to phrase a greater proportion of higher level (divergent) questions and at the same time show a significant decrease in the proportion of lower level (cognitive-memory) questions used for elementary science lessons, then it is possible that these prospective teachers can be more adequately prepared for the questioning aspect of the teaching act.

The questions written on the pre-test and post-test, evaluation of these questions by the panel of judges, the investigator's evaluation of questions written by all subjects, and the attitude questionnaire provided specific data necessary for the analyses employed in each of the three sections of this chapter. It was determined that the analysis would be made first by establishing an interjudge reliability from a random sample of questions written by the subjects on the pre-test and post-test measures to determine the reliability of the investigator's evaluation of questions written by all subjects. From the investigator's evaluation, each frequency was converted into a proportion to make the data more meaningful. Once the frequencies of questions written by each subject were converted to proportions, the change in the types of questions written from the pre-test to post-test was used to determine the significance of these changes by means of a chi square analysis.

The questions to be resolved in this study, as they were presented in Chapter I, are as follows:

1. Can prospective elementary teachers, as represented by the subjects in this study, learn to identify effectively-phrased questions through instruction?

2. Can prospective elementary teachers, as represented by the methods students in this study, learn to construct effectively-phrased questions by instruction?

3. Can prospective elementary teachers learn by instruction to rephrase poorly-phrased questions and hypothesize their probable responses?

4. Can prospective elementary teachers improve their capacity to construct a greater number of divergent questions as opposed to a lesser number of cognitive-memory questions for science lessons as a

result of instruction that involves the analysis of video-taped lessons demonstrating the use of these types of questions?

5. Can prospective elementary teachers learn to identify effective and ineffective questioning techniques through a method of instruction that involves the analysis of lessons using both effective and ineffective questioning techniques?

6. Can prospective elementary teachers learn to identify poorly phrased questions and judge more critically and accurately the effectiveness of a questioning pattern on the basis of the responses given by children as observed and analyzed from audio and video-taped lessons?

The investigator chose to resolve solutions to these questions by testing the following null hypotheses:

Hypothesis 1. There is no significant difference in the number of subjects constructing a greater proportion of cognitive-memory questions on the post-test and the number of subjects constructing a greater proportion of cognitive-memory questions on the pre-test.

Hypothesis 2. There is no significant difference in the number of subjects constructing a greater proportion of convergent questions on the post-test and the number of subjects constructing a greater proportion of convergent questions on the pre-test.

Hypothesis 3. There is no significant difference in the number of subjects constructing a greater proportion of divergent questions on the post-test and the number of subjects constructing a greater proportion of divergent questions on the pre-test.

Hypothesis 4. There is no significant difference in those subjects changing from a greater proportion of cognitive-memory questions on the pre-test to a greater proportion of divergent questions on the post-test and those changing from a greater proportion of divergent on the pre-test to a greater proportion of cognitive-memory on the post-test.

The "sign" test[1] was used to determine whether the propsective teachers included in this study tended to ask different types of questions following the instruction. In the "sign" test the direction of the difference between paired values is recorded with either a "+" or "-" sign for any given category. The null hypothesis tested by the "sign" test is that each difference has a probability distribution with the median equal to zero. The direction of the difference in each category from pre-test to post-test was recorded for each subject. The signs in each category were totaled and the chi square test of significance was applied to these values with one degree of freedom. When a significant change was determined for the cognitive-memory and divergent categories, each subject was assigned to a specific category on the basis of his predominent mode of questioning on the pre-test and post-test. This procedure was used to determine the direction of change from one category to another from the pre-test to the post-test. To determine the significance of this shift, the chi square statistical test was conducted. It was decided by the investigator that all hypotheses tested statistically would be rejected at the .05 level of significance. If the results were significant at the .01 level or beyond it was reported as such. To represent the evaluation of the instructional procedure determined from results of the attitude questionnaire the responses were summarized as proportions and ranked means. Because there were no questions identified as evaluative questions in this investigation, the investigator considered it non-functional and did not include it in the analysis.

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[1] Walker, H. M., and Lev, Joseph, Statistical Inference, pp. 430-431.

Determination of a Reliability Estimate of Interjudge Agreement

To establish interjudge reliability, the frequency and per cent of agreement by categories was determined for each level of agreement for the pre-test items included in the sample. These quantities are shown in Table 1.

TABLE 1. AGREEMENT BETWEEN JUDGES BY CATEGORIES FOR ALL PRE-TEST QUESTIONS IN THE SAMPLE

Number of judges selecting most frequent category	Cognitive-memory	Convergent	Divergent	Ties and mixes	Total	Per cent
7	44	10	4		58	45.70
6	17	10	1		28	22.08
5	14	3	3		20	15.75
4	6	5	2		13	10.24
3	2	1	1	4	8	6.30
Total	83	29	11	4	127	
Per cent	65.35	22.83	8.67	3.15		

Two different observations were drawn from the data presented in Table 1. First, the frequency and percentage of questions identified with the cognitive-memory category, as evaluated by the judges, illustrates the emphasis the subjects gave to these questions prior to the instruction. With 65.35 per cent of the questions written by the subjects included in the sample identified with this category, it would suggest that a greater proportion of the questions written by all subjects fell into this category. The disproportion of divergent questions, 8.67 per cent, to cognitive-memory questions is evident. Secondly, a high percentage of agreement can be observed with no less than six of the seven judges agreeing on 67.78 per cent of the questions, while complete agreement is reached for 45.70 per cent of the sample questions.

To establish interjudge reliability, the frequency and per cent of agreement by categories was determined for each level of agreement for the post-test items in the sample. These quantities are shown in Table 2.

From Table 2 nearly the opposite disproportion can be observed, with 52.59 per cent of the questions from the sample identified with the divergent category while 18.52 per cent of the post-test items are identified with the cognitive-memory category. Also observed from Table 2 is the decline in the degree of agreement between the judges. This decline in agreement is determined by contrasting the proportions observed from the convergent and divergent categories in Table 1 with those in Table 2. A substantial increase in the extent of agreement at the 6-1 and 5-2 levels can also be determined. Because the post-test was judged to be representative of a greater proportion of these types

TABLE 2. AGREEMENT BETWEEN JUDGES BY CATEGORIES FOR ALL POST-TEST QUESTIONS IN THE SAMPLE

Number of judges selecting most frequent category	Cognitive-memory	Convergent	Divergent	Ties and mixes	Total	Per cent
7	5	4	16		25	18.52
6	9	4	15		28	20.74
5	7	14	29		50	37.04
4	4	10	10		24	17.78
3	0	2	1	5	8	5.92
Total	25	34	71	5	135	
Per cent	18.52	25.18	52.59	3.71		

of questions, the decline in the extent of agreement suggests some limitations to applying the criteria established for these categories.

To establish interjudge reliability, the total frequency and per cent of agreement by categories was determined for each level of agreement between the seven judges. These quantities are shown in Table 3.

The data summarized in Table 3 demonstrates more of a balance of questions identified with each of the three categories. It also reflects on the degree of agreement between the seven judges with no less than five of the seven agreeing on 79.77 per cent of the items from the entire sample.

TABLE 3. AGREEMENT BETWEEN JUDGES BY CATEGORIES FOR ALL QUESTIONS IN THE SAMPLE

Number of judges selecting most frequent category	Cognitive-memory	Convergent	Divergent	Ties and mixes	Total	Per cent
7	49	14	20		83	31.68
6	26	14	16		56	21.37
5	21	17	32		70	26.72
4	10	15	12		37	14.12
3	2	3	2	9	16	6.11
Total	108	63	82	9	262	
Per cent	41.22	24.05	31.30	3.43		

To establish interjudge reliability, the frequency and per cent of agreement between the judges and the investigator for all items in the sample was determined for each category. The results are summarized in Table 4.

TABLE 4. FREQUENCY AND PER CENT OF AGREEMENT BETWEEN JUDGES AND INVESTIGATOR BY CATEGORIES FOR ALL ITEMS IN SAMPLE

Category	Pre-test			Post-test			Total		
	Total items	Total agreement	Per cent	Total items	Total agreement	Per cent	Total items	Total agreement	Per cent
Cognitive-memory	83	81	97.59	25	23	92.00	108	104	96.29
Convergent	29	24	82.75	34	24	70.58	63	48	76.19
Divergent	11	10	90.90	71	62	87.32	82	72	87.80
Total	123	115	93.49	130	109	83.84	253	224	88.88

From Table 4 the percentage of agreement between the judges and the investigator can be observed for each category and all items included in the sample. The judges and the investigator disagreed on 29 items from the sample analyzed. Eight of these items were on the pre-test and 21 on the post-test while nine of these items were identified as ties. The greatest disagreement was with convergent questions from the post-test. This is reflected in the 70.58 per cent figure for this category observed from Table 4. The high percentage of agreement for the divergent and cognitive-memory categories for both pre-test and post-test items suggests confidence in the judgment of the investigator for judging the questions written by the subjects. The total percentage of agreement between the judges and the investigator was determined to be 88.55 per cent for all items included in the sample. This degree of agreement suggests reliable estimates on the part of the investigator.

A reliability coefficient was determined using Ebel's[2] formula for reliability by the interclass correlation to estimate reliability for ratings by judges the results of this procedure are summarized in Table 5.

The formula used to determine the coefficient is as follows:

$$r_{kk} = \frac{V_q - V_e}{V_q} = \frac{4.21 - .40}{4.21} = .905$$

The coefficient is .905.

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[2] Guilford, J. P., Psychometric Methods, pp. 395-397.

TABLE 5. ANALYSIS OF VARIANCE DATA USED DETERMINING AN ESTIMATE OF THE RELIABILITY OF THE RATINGS BY THE JUDGES AND THE INVESTIGATORS

Source	Sum of squares	Degrees of freedom	Variance
Questions	1099.68	261	4.21
Judges	155.85	7	
Error	733.90	1827	.40
Total	2029.43	2095	

From Table 5 the reliability of agreement between the judges and investigator was determined to be .905 for all items in the sample. This reliability coefficient permits a high degree of confidence in the reliability of the judgment of the investigator for his judgment of the questions written by all subjects in the study.

Improvement in Capacity to Construct Effectively-Phrased Questions

To determine the change in the capacity for the subjects to construct questions, the frequencies and percentages of questions by categories for each subject were determined by the investigator. A summary of this procedure is presented in Table 6.

The frequencies and percentages summarized in Table 6 suggest the possibility of change from a greater proportion of cognitive-memory questions on the pre-test to a greater proportion of divergent questions on the post-test. This is suggested by the observation that the convergent category remains stable and the proportion of change within the cognitive-memory and divergent categories is nearly the same. A degree

TABLE 6. INVESTIGATOR'S JUDGMENT OF QUESTIONS CONSTRUCTED BY ALL SUBJECTS

Test	Subjects	Total questions	Cognitive-memory		Convergent		Divergent	
			Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
Pre-test	36	246	161	65.20	51	20.60	35	14.20
Post-test	36	376	131	34.70	78	20.80	167	44.50

of confidence can be expressed in the reliability of the shift out of the cognitive-memory category. It appears that less confidence can be expressed for the shift into the divergent category. The complete evaluations for each subject are contained in Appendix M.

To demonstrate change in the types of questions constructed from pre-test to post-test, the individual subjects were identified with one of four percentage ranges for each category. The frequencies for each of these ranges are described in Table 7.

TABLE 7. PERCENTAGE RANGES FOR ALL SUBJECTS ON THE PRE-TEST AND POST-TEST

Percentage range	Cognitive-memory		Convergent		Divergent	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
0- 25	4	15	36	25	29	4
26- 50	5	14	14	11	5	22
51- 75	16	7	1		2	8
76-100	10					2

The observation from Table 7 is that the major changes in the proportion of questions constructed before and after instruction were with those questions identified as divergent and cognitive-memory. The frequencies shown in the cognitive-memory category in Table 7 demonstrate a definite reduction in the percentage of these types of questions constructed after instruction. An increase in the percentage of divergent questions constructed can also be observed. Twenty-nine of the 36 subjects constructed less than 25 per cent divergent questions prior to instruction while 30 of the 36 subjects wrote 26 to 75 per cent divergent questions after instruction.

To determine the direction of change for each individual subject by categories from pre-test to post-test the sign test was applied to the paired percentages for each category. The results of this procedure are shown in Table 8.

The observations for all paired proportions for each subject were listed for that subject in each category. The directions of the differences between the paired values was recorded with a "+" or "-" sign. It was observed that in the cognitive-memory category a total of 32 "-" signs were recorded demonstrating that these subjects had shown a reduction in the proportion of cognitive-memory questions asked from pre-test to post-test while only four subjects had shown a "+" sign change. In the convergent category, 13 subjects demonstrated change in the "+" direction while 21 changed in the "-" direction. Thirty-one subjects showed "+" sign changes in the divergent questions asked from pre-test to post-test while five demonstrated "-" sign changes. The significance of these changes was tested by applying the chi square test of significance.

TABLE 8. SIGN TEST FOR DIRECTION OF CHANGE IN PROPORTION OF QUESTIONS CONSTRUCTED BY EACH SUBJECT

Subject	Cognitive-memory			Convergent			Divergent		
	Pre-test	Post-test	Sign	Pre-test	Post-test	Sign	Pre-test	Post-test	Sign
1	75	12	-	13	13	0	12	75	+
2	0	67	+	33	0	-	67	33	-
3	50	17	-	37	33	-	13	50	+
4	25	20	-	50	0	-	25	80	+
5	80	37	-	0	13	+	20	50	+
6	57	0	-	29	25	-	14	75	+
7	44	38	-	22	38	+	34	24	-
8	67	10	-	33	40	+	0	50	+
9	86	56	-	14	11	-	0	33	+
10	100	17	-	0	50	+	0	33	+
11	43	0	-	57	0	0	0	100	+
12	63	50	-	37	13	-	0	37	+
13									
14	67	0	-	33	25	-	0	75	+
15	67	10	-	33	20	-	0	70	+
16	71	25	-	15	25	+	14	50	+
17	92	33	-	0	11	+	8	56	+
18	86	14	-	14	29	+	0	43	+
19	67	50	-	16	13	-	17	37	+
20	80	58	-	20	14	-	0	28	+
21	67	38	-	33	25	-	0	37	+
22	100	21	-	0	29	+	0	50	+
23	50	25	-	50	25	-	0	50	+
24	56	25	-	11	50	+	33	25	-
25	57	31	-	14	7	-	29	62	+
26	25	27	+	50	27	-	25	46	+
27									
28	40	20	-	0	40	+	60	40	-
29	38	20	-	50	45	-	12	35	+
30	67	38	-	33	24	-	0	38	+
31	56	64	+	13	0	-	31	36	+
32	67	47	-	22	13	-	11	40	+
33	89	72	-	0	0	0	11	28	+
34	100	37	-	0	38	+	0	25	+
35	67	60	-	11	13	+	22	27	+
36	0	71	+	50	14	-	50	15	-
37	71	44	-	14	0	-	15	56	+
38	100	31	-	0	13	+	0	56	+

The chi square analysis of the sign test results for the cognitive-memory category with 4 "+" and 32 "-" is summarized in Table 9.

TABLE 9. CHI SQUARE TEST OF SIGNIFICANCE FOR COGNITIVE-MEMORY CATEGORY

Direction of change	Observed	Expected
+	4	18
-	32	18
Total	36	

$$\chi^2 = \frac{(O - E)^2}{E}$$

χ^2 (1 df) = 21.78, significant at .001 level.

Hypothesis 1. There is no significant difference in the number of subjects constructing a greater proportion of cognitive-memory questions on the post-test and the number of subjects constructing a greater proportion of cognitive-memory questions on the pre-test.

The obtained chi square value for the cognitive-memory category, 21.28, with one degree of freedom, was significant beyond the .001 level. Thus the null hypothesis was rejected. The number of subjects demonstrating a reduction in the proportion of cognitive-memory questions constructed after instruction was highly significant and not attributed to chance.

The chi square analysis of the sign test results for the convergent category with 13 "+" and 21 "-" changes in summarized in Table 10.

TABLE 10. CHI SQUARE TEST OF SIGNIFICANCE FOR CONVERGENT CATEGORY

Direction of change	Observed	Expected
+	13	17
-	21	17
Total	34	

χ^2 (1 df) = 1.88, not significant at .05 level.

Hypothesis 2. There is no significant difference in the number of subjects constructing a greater proportion of convergent questions on the post-test and the number of subjects constructing a greater proportion of convergent questions on the pre-test.

The obtained chi square value for the test of significance on the changes for the convergent category, 1.88 with one degree of freedom was not significant. Therefore the null hypothesis was not rejected. The difference in the number of subjects writing a greater proportion of convergent questions after instruction did not differ significantly from the number writing a greater proportion prior to instruction.

The chi square analysis of the sign test results for the divergent category with 31 "+" and 5 "-" changes is summarized in Table 11.

TABLE 11. CHI SQUARE TEST OF SIGNIFICANCE FOR DIVERGENT CATEGORY

Direction of change	Observed	Expected
+	31	18
-	5	18
Total	36	

χ^2 (1 df) = 18.78, significant at .001.

Hypothesis 3. There is no significant difference in the number of subjects constructing a greater proportion of divergent questions on the post-test and the number of subjects constructing a greater proportion of divergent questions on the pre-test.

The obtained chi square value for the test of significance of the differences in the paired proportions for the divergent category, 18.78, with one degree of freedom was significant beyond the .001 level. Thus the null hypothesis was rejected. The number of subjects demonstrating an increase in the proportion of divergent questions constructed after instruction was highly significant and not attributed to chance.

To determine the significance of the change made by those subjects that constructed a greater proportion of cognitive-memory questions on the pre-test to a greater proportion of divergent questions on the post-test, the subjects were assigned to a category according to the greater percentage of questions written on each test. The category with which a subject was identified was determined in the following way:

Cognitive-memory, when Cognitive-memory per cent was greater than Divergent per cent

Divergent, when Divergent per cent was greater than Cognitive-memory per cent.

In two cases Cognitive-memory proportion was the same as the Divergent proportion. These two cases were excluded. Therefore, subjects were identified in the following way:

1. (Cognitive-memory)-(Cognitive-memory) were subjects writing greater percentage of cognitive-memory questions on both tests.

2. (Cognitive-memory)-(Divergent) were subjects writing greater percentage of Divergent questions on the post-test.

3. (Divergent)-(Cognitive-memory) were subjects who wrote greater percentage of Divergent questions on the pre-test.

4. (Divergent)-(Divergent) were subjects that wrote greater percentage on both tests.

A chi square statistical test was used to determine the significance of the changes determined by this procedure, as summarized in Table 12.

TABLE 12. SIGNIFICANCE OF CHANGE FROM COGNITIVE-MEMORY TO DIVERGENT

Test	Post-test			
	Category	Cognitive-memory	Divergent	Total
Pre-test	Cognitive-memory	12 (a)	19 (b)	31
	Divergent	2 (c)	1 (d)	3
Total		14	20	34*

*Two subjects demonstrated no change.

The value of chi square was determined using the following formula:[3]

$$\chi^2 = \frac{(b - c)^2}{b + c}$$

The following key is used to interpret Table 12:

Cell b = number of subjects constructing a greater proportion of cognitive-memory questions on the pre-test but not on the post-test.

Cell c = number of subjects constructing a greater proportion of cognitive-memory on the post-test but not on the pre-test.

Cell a = number of subjects constructing a greater proportion of cognitive-memory on both tests.

Cell d = number of subjects constructing a greater proportion of divergent questions on both tests.

$$\chi^2 \text{ (1 df)} = 13.76\text{, significant at .001 level.}$$

Hypothesis 4. There is no significant difference in those subjects changing from a greater proportion of cognitive-memory questions on the pre-test to a greater proportion of divergent questions on the post-test and those changing from a greater proportion of divergent on the pre-test to a greater proportion of cognitive-memory on the post-test.

The obtained chi square value, 13.76, with 1 degree of freedom was significant beyond the .001 level. Thus the null hypothesis was rejected. Therefore, the number of individuals changing from a greater proportion of cognitive-memory questions on the pre-test to a greater proportion of divergent question is highly significant and not attributed to chance. It can be seen in Table 12 that 31 of the 34 subjects constructed a greater proportion of cognitive-memory questions on the pre-test whereas, only 14 of the 34 subjects constructed a greater proportion of cognitive-memory on the post-test. This shift from the cognitive-memory to the divergent category is highly significant.

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[3] Walker and Lev, op. cit., pp. 102-103.

Student Assessment of the Instruction Program

Students responded to a questionnaire on the value of the instruction on questioning. The extent of benefit derived from the instruction is summarized in Table 13.

TABLE 13. A SUMMARY OF THE RESPONSES ON PART I OF THE QUESTIONNAIRE

Items	Percentage of favorable change indicated by students		
	Very little	Some	Extensive
All A-K	5.64	17.44	76.65
	Percentage of unfavorable change indicated by students		
	Very little	Some	Extensive
L-N	42.33	28.82	27.92

From the data in Table 13, a large majority of students felt a substantial personal change. The respondents felt most improved in dealing with questioning as part of the teaching act and the least improved in their ability to critically analyze the questioning pattern used in teaching materials and judge the levels of thought displayed by children of different ages. Items L through N reflect the degree to which the students were more conscious of questioning in contrast to other aspects of the teaching act.

The ranking by students of the different phases of the instruction from least effective to most effective is summarized by ranked means in Table 14.

TABLE 14. SUMMARY OF THE RESPONSES TO PART II OF THE QUESTIONNAIRE

Ranked means for the eight point evaluation scale	
Phase of instruction	Mean
C	3.0
H	4.0
A	4.3
E	4.9
B	5.0
D	5.0
F	5.1
G	5.4

From the data presented in Table 18, the most effective procedure, as judged by the students, was that which involved analyzing lessons using both video- and audio-tapes. The least effective procedure was considered to be the written assignments.

The students responded to a questionnaire item that considered the phases of instruction that should be changed. Results of their responses are summarized in Table 15.

TABLE 15. SUMMARY OF THE RESPONSES TO PART III OF THE QUESTIONNAIRE

Phase of instruction	Per cent Yes	Per cent No	Per cent undecided
A	59.45	27.02	13.51
B	2.70	81.08	16.21
C	18.91	72.97	8.10
D	13.51	48.64	13.51
E	40.54	48.54	10.81
F	13.51	81.08	5.40

From Table 15, the aspect of instruction most desirous of change was the amount of time devoted to the instruction. Students felt that less time would put the questioning in its proper perspective. The aspect of instruction judged least desirous of change was the sequence used in the instructional program. A complete table of the responses to the questionnaire is shown in Appendix I.

Summary

The results obtained from the application of the "sign" test and the chi square analysis offer strong support to the hypothesis that prospective teachers can improve, as a result of instruction, in their capacity to construct effectively-phrased questions.

Within the limitations established for this study, significant differences were found in the following areas:

1. A decrease in number of subjects constructing a greater proportion of cognitive-memory questions after instruction from the number

constructing a greater proportion prior to instruction.

2. An increase in the number of subjects constructing a greater proportion divergent questions from the number constructing a greater proportion prior to instruction.

3. A shift from the number of subjects constructing a greater proportion of cognitive-memory questions prior to instruction to greater proportion of divergent after instruction.

Within the limitations established for this study, a significant difference was not shown for the number of subjects constructing a greater proportion of convergent questions before and after instruction. If a significant difference had been determined, no assumption could be made about shift out of the cognitive-memory category. Because non-significance was demonstrated for this category and significant changes were shown for the cognitive-memory and divergent categories, it seems reasonable to suggest that the demonstrated significant change from a greater proportion of cognitive-memory questions prior to instruction to a greater proportion of divergent questions after instruction was the major change.

The determination of a reliability estimate demonstrated a substantially high degree of interjudge agreement permitting confidence in the judgment of the investigator for classifying questions according to the established scheme.

The decline in agreement demonstrated from the evaluations of post-test questions has pertinent implications for the limitations for the categories as criteria for identifying questions. These implications are discussed in Chapter V.

The responses to the opinion questionnaire demonstrated a highly favorable attitude toward the instruction on questioning with the instructional technique based on the analysis of audio- and video-tapes in combination seen as the most favorable. The length of the period of instruction and written assignments were of questionable value.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Summary

The acceptance of elementary school science as an established part of the curriculum has drawn extensive attention to the quality of science instruction at this level. The contemporary approaches demonstrate a concern for improving science education for children. This increased attention directed toward elementary school science has been created and influenced by the curriculum development projects that have emerged in recent years.

These programs have sought to provide experiences for children based on learning the processes or methods, as well as the content of science. The focus has been on the teaching and learning of science as inquiry. As a result, educators have become increasingly aware of the extent to which children are capable of understanding concepts that were thought previously to be too difficult. In addition, curriculum development programs, drawing upon the studies of the developmental psychologists, have proposed that science be taught in a developmental sequence moving from simple concepts to complex, and from concrete to abstract. The emphasis is on providing conceptual development by involving children in the processes of science through making observations, collecting data, formulating hypotheses, making inferences, and experimenting.

To accomplish such goals, the teacher's role takes on a new focus and significance. The teacher must be able to structure learning experiences that meaningfully provide for these kinds of operations. Although the curriculum development programs have sought to enhance teacher competencies, the proposed programs probably have done more to compound the dilemma for elementary teachers. These programs have brought to light many of the teacher problems. It has been shown that teachers do not understand inquiry and therefore are unable to construct experiences in the processes for children. This inadequacy arises from a variety of sources but the fault probably lies more with programs of preparation. Courses preparing teachers probably have done more to perpetuate the problems rather than to deal with them. It is evident that the requirements of the contemporary curriculum projects for teacher competencies must be identified and strategies developed for programs of preparation that will best prepare teachers to cope with these new approaches. Means for enhancing these competencies must be devised to serve as the main focus of methods courses. One of these competencies is skill in questioning. The extensive attention on elementary science has stimulated concern for teacher skill in identifying purposeful objectives, constructing meaningful learning experiences, encouraging inquiry, providing for individual differences and evaluating individual progress. It is not difficult to demonstrate that skillful questioning on the part of the teacher can be crucial to all of these areas. Skillful questioning is vital to many aspects of the teaching-learning process. This is demonstrated by its commonality to classroom activity. Like other competencies demanded of teachers, questioning has not been isolated for study and prescribed for development in methods courses. If methods courses are to serve the purpose of adequately preparing teachers to handle the demands placed on them, then they should provide direct and meaningful experiences that will command skill in the desired competencies. To be meaningful, these competencies must be developed within a context that is commensurate with current trends.

This study was designed to explore a method described for the purpose of isolating some aspect of the teaching act with the intent of developing skill in its use. Emphasis was placed on observing and analyzing questions and questioning patterns used in actual classroom situations for the purpose of establishing criteria that would permit distinguishing effective approaches from less effective approaches.

The primary purpose of this investigation was to cause change in the questioning practices of prospective elementary teachers. It was concerned with determining the degree to which a prescribed method of instruction could accomplish this end. With the primary focus on proper phrasing of questions, the investigator described techniques that used the analysis of video-taped lessons as a basis of the instruction.

The judgment of this desired improvement was based on the premise that it could be recognized by the increase in the proportion of divergent questions constructed by the students in this study after the instruction had been employed. Therefore, the analysis used in the study sought recognizable change from a greater proportion of cognitive-memory questions prior to instruction to a greater proportion of divergent questions after instruction.

The scope of the study was limited to 38 elementary education majors attending a large midwestern university. These students were either second semester juniors or first semester seniors enrolled in two classes of elementary science methods during the spring semester of 1968. These classes were treated as one group and given the same instruction.

The study was conducted in a span of nine 45-minute class periods. The pre-test measure was administered on the first day, followed by seven days of instruction, and the post-test on the ninth day.

The collection of data for this study was dependent upon the questions written by the subjects on the pre-test and post-test instruments and their evaluations by the seven judges and the investigator. These instruments were based on actual classroom lessons presented by audiotape and a printed dialogue that required the students to reconstruct the questions and questioning pattern used in the lesson in accordance with specified criteria.

Data secured from the pre-test, post-test, and the opinion questionnaire were analyzed statistically and subjected to a descriptive analysis by the investigator. The sign test and chi square statistical test were used to determine the change brought about by instruction and the direction of this change as reflected in the pre-test and post-test results.

The major aspects of the study were tested by acceptance or rejection of the following hypotheses stated in null form:

Hypothesis 1: There is no significant difference in the number of subjects constructing a greater proportion of cognitive-memory questions on the post-test and the number of subjects constructing a greater proportion of cognitive-memory questions on the pre-test.

Hypothesis 2: There is no significant difference in the number of subjects constructing a greater proportion of convergent questions on the post-test and the number of subjects constructing a greater proportion of convergent questions on the pre-test.

Hypothesis 3: There is no significant difference in the number of subjects constructing a greater proportion of divergent questions on the post-test and the number of subjects constructing a greater proportion of divergent questions on the pre-test.

Hypothesis 4: There is no significant difference in those subjects changing from a greater proportion of cognitive-memory questions on the pre-test to a greater proportion of divergent questions on the post-test and those changing from a greater proportion of divergent on the pre-test to a greater proportion of cognitive-memory on the post-test.

Findings

On the basis of the accumulated data, and within the limitations of this study, the following findings were drawn:

1. From the use of the four cognitive categories, as defined for this study, the following could be demonstrated:
    a. A reliably high percentage (88.55 per cent) of interjudge agreement between the seven judges and the investigator for all items included in the sample.
    b. A reliably high estimate of the interjudge reliability with a coefficient determined to be .905.

2. A significant reduction of the number of prospective teachers constructing a greater proportion of cognitive-memory questions after instruction.

3. A significant increase in the number of subjects constructing a greater proportion of divergent questions after instruction.

4. A significant increase in the number of subjects changing from a greater proportion of cognitive-memory questions before instruction to a greater proportion of divergent questions after instruction.

5. No significant difference in the number of subjects constructing a greater proportion of convergent questions from pre-test to post-test.

6. A decline in the level of agreement among the panel of judges when evaluating a greater number of convergent and divergent questions.

7. A high percentage (76.65 per cent) of the students reporting a highly favorable attitude toward the influence of instruction to change their ability to identify and construct effective questions.

8. A greater consciousness of the role of questioning in the teaching act, reflected by the responses on the opinion questionnaire.

9. A highly favorable influence of the procedures involving the analysis of video-taped lessons for causing change in ability to identify and construct effective questions.

10. An unfavorable attitude concerning the extent of time devoted to the instruction.

11. Student difficulty with constructing a questioning pattern during the instruction demonstrated a problem for evaluating questions out of context and a need for more than divergent questions in a questioning pattern.

Conclusions

Based upon the analysis of the findings of this investigation the following conclusions are drawn:

1. The ability of prospective elementary teachers to identify and construct effectively-phrased questions for elementary school science lessons can be improved through instruction.

2. A method of instruction that employs the use of the analysis of video-taped lessons can be effective for improving the ability of prospective elementary teachers to identify and construct effectively-phrased questions.

3. Through an instruction that employs the analysis of video-taped classroom lessons, prospective elementary teachers can improve their capacity to construct a greater proportion of divergent questions for science lessons.

4. Prospective elementary teachers through an instruction that employs the analysis of video-taped classroom lessons can improve their capacity to rephrase poorly-phrased questions so that they are effectively-phrased questions.

5. Because the proportion of convergent questions constructed does not change significantly from pre-test to post-test, it would suggest that convergent questions are also important to effective questioning.

6. Even though conclusive data is not available, the evidence drawn from the data suggests that one aspect of a questioning technique is determined by the type of questions employed in a lesson segment. The

increased number of effectively-phrased questions following the instruction period suggests that prospective elementary teachers are able to identify effective and ineffective questioning techniques, at least in part.

7. Even though conclusive data is not available, the evidence drawn from the data suggests that effectively-phrased questions are questions which allow for more divergent responses and a questioning pattern can be judged from the responses of the students, the investigator feels that the subjects are capable of evaluating questioning patterns more critically as a result of the increased ability to construct a set of more divergent questions.

Implications

Certain implications seem to be appropriate in light of the conclusions drawn. These implications are:

1. It can be implied from the data that experience with analyzing classroom situations is important to improving the ability to construct effective questioning practices.

2. It can be implied from the data that since the proportion of convergent questions did not change significantly after instruction that effectively-phrased convergent questions are also important for questioning patterns. Therefore, it can also be implied that a divergent question is not always the most desirable or appropriate question.

3. It can be implied from the data that the four categories, cognitive-memory, convergent, divergent and evaluative, as criteria for

classifying questions have some merit but also offer some limitations. These limitations were illustrated by the determination of the evaluative category as a nonfunctional category and the decline in agreement between the judges when a greater number of convergent and divergent questions were evaluated. It can be further implied that there is a need for different ways of judging the effectiveness of a question since sometimes the true effects of it are not immediately detected.

4. It can be implied from the follow-up procedures that improved ability for constructing effectively-phrased questions does not assure improved ability to use these questions during the teaching act.

5. It can be implied from the results of the opinion questionnaire that adaptations to the prescribed methodology might be more effective for developing skill in matching questioning practices with levels of thought displayed by children.

6. It can be implied from the experience in the instructional program and opinions expressed on the questionnaire, that caution should be given to the possible result of causing teachers to be hypercritical of questions and questioning practices rather than examining them in light of the most suitable purposes they may serve.

7. It can be implied that a greater consciousness of effective and ineffective practices in questioning from the analysis of videotaped lessons prepares the student for a more adequate understanding of the teaching act and of the need for a carefully planned approach.

8. It can be implied from the experiences in the instructional period that questioning must be preceded by experiences that give purpose to a questioning procedure. Some event must establish direction and meaning for the questioning.

9. It can be implied from the results of the opinion questionnaire that a less concentrated approach during the instruction on questioning might be more effective, thus, allowing time for evaluating individual progress and relating questioning to many more aspects of teaching.

10. It can be implied from the results gathered in this study that there are many aspects to questioning and many factors that influence a question's function. Therefore, it is difficult to deal with a question or questioning pattern out of its established context.

Recommendations

In view of the evidence collected in this study the investigator presents the following recommendations:

1. Those responsible for elementary science methods instruction should explore new ways to involve prospective elementary teachers in direct and meaningful experiences that permit developing skill in questioning. Evidence from the opinion questionnaire used in this study reflects a desire and definite need for practical experiences with questioning procedures.

2. Those responsible for elementary science methods should incorporate methods that involve the analysis of classroom lessons as a means for developing skill in questioning. Experiences that would permit prospective teachers to explore different types of questions and questioning patterns in a classroom situation or with children, should be structured and included in a program of preparation. Evidence from

this study suggests that teachers can be made more aware of a need for purposeful questioning and its influence on the classroom activity.

3. Research should be done to determine other factors that influence questioning practices and methods should be designed to develop or eliminate these factors depending on the quality of their influence. It is the recommendation of the investigator that responsible individuals should give more extensive treatment to specific aspects of the method used in this study. The test of some problem, technique, or defect would be meritorious of further investigation. More objective means need to be devised to evaluate questions and questioning patterns. Research that would result in some evaluative procedures or an interaction scheme could prove fruitful.

4. If other researchers were to replicate this study, the investigator strongly recommends that opportunities be provided for students to have "check points" throughout the instruction where strategies could be tested in the classroom thereby revising approaches to questioning during the course of the instruction.

5. Experiences with questioning procedures should be designed to permit prospective teachers to increase their ability for self-evaluation and thus develop teaching strategies commensurate with their experiences and contact with the classroom situation. Methods should also be designed and used that would help prospective or experienced teachers to develop strategies for sequencing questions. Students in methods classes should have opportunities to judge alternative strategies of sequencing for the types of learning that they stimulate. Skill in sequencing could be developed through analysis of written and oral problem

situations and simulation might be used to practice classroom presentations for the purpose of developing sequencing skills.

6. Research should be conducted to ascertain methods that will develop skill in using effectively-phrased questions and effective questioning techniques in the teaching act. What are some methods that would develop skill in relating to children through effective questioning?

7. Related to many of the other recommendations is the need for developing the proper attitude toward questioning. It is likely that teachers can better learn how to question if they have developed empathy with those being questioned--empathy that can be developed only through having experience with both effective and ineffective questioning practices.

8. The investigator suggests that training sessions similar to those used with the classroom teacher responsible for the video-tapes used in the instruction of this study would be beneficial to prospective teachers. Sessions of this type would require closer analysis, on the part of the individual student, of the effects of designed questions and questioning techniques.

9. A program of instruction should be dispersed over a longer period of time to relate it to many aspects of teaching. With adequate time, more attention could be given to checking the progress of the individual as he relates this skill to other aspects of the teaching act. This could make skill in questioning more purposeful, as well as, provide for a more individualized treatment.

10. Inservice programs for elementary teachers should stress effective questioning practices. Because of the emphasis on the inquiry

processes in elementary science and because questioning is important for developing inquiry skills, teachers should have experiences with methods that incorporate question-asking skills as a basis for constructing learning situations.

11. There is no evidence in this study that indicates that experience with questioning procedures should be exclusive to the preparation for teaching science. Attention should be given to questioning in other areas, and developing skill with questioning for different purposes. For example, skillful questioning on the part of the elementary teacher could enhance the desired outcomes in a reading program.

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APPENDIX

Appendix A

Names and Background of the Seven Evaluators Whose Expert Opinion Was Sought to Establish Interjudge Reliability

Names and Background of the Seven Evaluators Whose Expert Opinion Was Sought to Establish Interjudge Reliability

1. Mr. Robert Green with thirteen years teaching experience at the elementary school level in science, mathematics and social studies in the States of Georgia and Indiana, is presently teaching elementary science and mathematics at University School, Bloomington, Indiana.

2. Mr. Lewis Konetski with three years of experience teaching general science at the Junior high school level in Levittown, Pennsylvania, is presently a doctoral student at Indiana University.

3. Mr. Paul Koutnik with five years teaching experience in biology at Joliet High School in Joliet, Illinois and one year of experience teaching elementary school science methods at Indiana University, is at present a doctoral student at Indiana University.

4. Mr. George Ladd with four years of teaching experience in earth science and biology at the junior high school level in Phoenix, New York, is at present a doctoral student at Indiana University.

5. Mrs. Karen Stuckey with eight years of teaching experience in upper elementary, five years at University School, Bloomington, Indiana, is at present science coordinator of intermediate grades at University School.

6. Mr. Donald Troyer with seven years of experience teaching high school biology at Culver Military Academy in Indiana, is presently a doctoral student at Indiana University.

7. Mr. Robert Ward with eight years of teaching experience at the elementary and junior high school level in the State of Washington, is at present a doctoral student at Indiana University.

Appendix B

Instrument Utilized for the Pre-testing and the Related Dialogue

This is a dialogue of a science lesson conducted by a student teacher while working with a class of second grade children (seven year-olds). The teacher's main concern in this lesson is to develop an ability to observe and make accurate descriptions of these observations. She also hopes that the children will generate many ideas to explain their observations and to suggest variables that can be introduced to change what they have observed about the drops of water. Therefore, this teacher has identified the following as her objective for this lesson:

Given a piece of waxpaper, newsprint, a medicine dropper, and water, the children will be able to make observations of what happens when they place drops of water on two different surfaces and explain in their own words why this happens. They will also be able to suggest changes that can be introduced, predict what will happen if these changes are made, and verbally describe the observed results of these changes.

1. The teacher in this lesson started the lesson with questions one through five. What can you do to construct a more exciting beginning to this lesson and still establish the problem of the activity as it is defined within the limits of the objective?

2. There are many questions the teacher could ask for initiating the discussion in this lesson. Write out as many possibilities as you can for questions that could be used for this purpose. List no more than fifteen.

3. If you were told that you could use only one question for initiating this lesson, what would be your best question for establishing the problem of the lesson and getting the children excited about the activity? (You may qualify if necessary).

4. You have listened to the actual lesson, and you have examined the dialogue of the questions and responses. What questions would you ask for the activity that takes place in the section of the lesson described by question number twelve to question number twenty=three in order to make it more interesting to the children? If possible, include questions that do the following:

a. cause the children to make more complete observations,

b. cause the children to make more accurate descriptions and to state relationships,

c. cause the children to make inferences about their observations (explanations),

d. and/or cause the children to suggest ways of extending this activity to lead to further experimentation by

(1) making predictions,
(2) hypothesizing about certain changes,
(3) and/or suggesting changes they could introduce in the activity.

Dialogue of a Science Lesson

Grade and Age: Second (seven year-olds)

Teacher: A Student Teacher

"Some Experiments With Water"

1. You have learned a lot about water haven't you?
R. Yeah .

2. If we are going to look at water, we are going to have to put it on something aren't we in order that we can look at it, sort of play with it and experiment?

3. I thought of two things we could put it on and I wondered if you could tell me which one would be the best? I thought either newspaper or waxpaper. Which one do you think would be the best to play with the water?
R. Waxpaper.

4. Why do you say that?
R. Cause with the other paper it would go right through .

5. You think it would? Do you all think that?
R. Yes .

(Place water on newspaper)

6. What happens when you first put it on the paper?
(no response)

7. Does anyone know? Look at -------
R. Stays in ball.

8. What happens to yours Steven?
R. Mine stayed in a little ball then it starts to sink down .

9. How about you Jeff?
R. Well, mine stays in a little ball then sinks in .

10. Do you think it would be very easy to play with this one here and roll it around?
R. No .

11. Do you think this would be better?
R. Yes.
(test on waxpaper)

12. What do you notice about the water?
R. When I move the waxpaper it slides .

13. Did it sink in like it did on the other?

14. Does anybody else notice anything else?
R. Well, when I put my dipper in, it follows the dipper .

15. What else can you do with the water? Nobody notices anything?
R. You can make it stretch and make pieces out of if.

16. Compare the big beads of water with the little ones. What do you notice about that?
R. It gets bigger.

17. It gets bigger? What gets bigger?
R. The water. The little ball of water gets bigger .

18. What about the shape? Does the shape change when you put more water on it?
R. No .

19. Put a little one beside a great big one and see what happens. A little tiny drop.
R. It does .

20. What?
R. It changes the shape .

21. Whats different about the chape?
R. Well, its not exactly round.

22. Which one got round?
    R. The big one.

23. The big ones flatter. Do you all see that?
    (try candle)

24. Well why don't you take your candle and little tiny bubble of water and get a pretty little one and try to stick the candle in it and see if you can tell me about what happens?

25. Does the candle go in? What happens?
    R. It bounces off.

26. What else do you notice?
    R. It scoots away.

27. It scoots away and won't let the candle in, is that it?
    R. Yes.

28. Look at the candle, is it wet?
    R. Yes.

29. Is it wet? Really wet?
    R. No.

30. Does it shed the water?
    R. No.

31. Have you ever seen insects that can walk on the water?
    R. Yes.

32. How do you think they do this? Does this tell you anything about what they might have on their legs maybe that keeps them up?
    (no response)

33. What's the candle made of?
    R. Wax.

(ink in bubbles of water that children have on wax paper)

35. Do you notice anything different about this?
    R. No.

36. Did it change the shape?
    R. No.
    R. The ink did.
    R. It turns color.

37. Did it really change the water as far as shape or anything?
    R. No.

(Paper towel into blue water)

38. What does the water do?
R. It absorbs the water.

39. Then is this paper towel more like the waxpaper or like the newsprint?
R. Newspaper.

40. Why?
R. Because it can soak through and it is also going into it.

41. It absorbed all the water?
R. It turned the paper towel green.

42. With your eye dropper move one drop over near the other one and tell me what happens when they get real close-what happens?
R. They get bigger circle.
R. Mine joined together.
R. I was going to say what he said.
R. Went together.

43. What do you think causes that?
R. The air.
R. I don't know .
R. I don't know .
(Try again)

44. What happens?
R. Bigger one soaks it up.
R. My little one soaked up the big one.
R. They hook together and get bigger.

45. Could one say that they attract each other? Do you know what that means?
R. Yes
(Make little drops)

46. Have you got a lot of little ones now?
R. Yes.
(Tilt paper)

47. What happens?
R. When I tipped mine up my drops fell off.

Appendix C

Transcribed Dialogue for the Video-taped Lesson Used in the Instruction to Characterize Poorly-phrased Questions and Ineffective Techniques

Dialogue of Lesson

Poorly-phrased Questions and Ineffective Techniques

Tape: Number One

Teacher: Miss Mary Ann DeBaggio

Date: February 2, 1968

Grade: Sixth (eleven year-olds)

Demonstration: Whizzbang-Projectiles

1. What did we see happening? Were the balls hitting the ground at the same time?
R. Yes.

2. What scientific principle was involved in getting the balls to hit the ground at the same time?
R. Gravity.

3. How does gravity affect the balls?
R. Well, it pulls them down.
R. Force.

4. Gravity is like a force?
R. I mean a push.

5. Is there a difference between a force and a push?
R. Well, force is two things.

6. What are the two things a force is?
R. Push and a pull of the earth.

7. Do you think this is an electromagnent?
R. Could be.

8. Is it, yes or no?
R. Yes.
R. If that is an electric battery, it probably is.

9. What do you think this tin can is made out of?
R. Tin (teacher says-I don't think so)
R. Metal.

10. What kind of metal?
R. Silver
R. What is an electromagnet? (teacher explains)

11. I'm wondering if this tin can will connect up?
R. If its made out of some sort of steel, then it will.

12. Anyone know for sure what this can is made up of?
R. Is it made of aluminum? (Teacher tells to look it up)

13. Do you think, that if this is an electromagnet, this will stick together?
R. Yes.
(How about that)

14. Do you think we could consider this the gun?
R. Yes.

15. What's my ammunition made of?
R. Its a candle.

16. If I blew into the tube, will that be a force?
R. Yes.

17. What kind of a force, a push or a pull?
R. Push

18. What do you think will happen if I blow through here?
R. Candle will fly out.

19. Do you think maybe the can will fall off?
R. I don't think it will go.

20. Do you think the can will fall off of where it is sitting?
R. It will because of the way you have it fixed.
R. I don't think you can blow hard enough.

21. You don't think I could blow it so it would go that far?
R. No.
R. I don't think the can will fall off.
(teacher says-let's try it)
(Phsff-sound of failure)

22. Hum, what do you think is the problem? Do you think those wires were in the way?
(can falls when wires are separated)

23. Gee, do you think the can will fall off?
(Laughter)

24. What do you think made the can fall off?
R. Because you wiggled the wires and then the can.

25. What would that have to do with it?
(no response)

26. What scientific principle would explain all that?
R. It might be that when you fidgeted with the wires that it broke the electricity coming into it.

27. Shall I try it again and see if I can get the whole thing to work this time?
(no response)

28. What do you think is making the can fall down, besides the fact that the wires are disconnected? Is there any force that is acting on it?
R. Gravity.

29. Do you think that if the candle went out of the tube, what forces would be acting on it? One force or two forces?
R. Two-you and gravity.

30. Push forces or pull forces?
R. Both.

31. Which would be which?
R. When you blow it, that would be push force, and gravity would be pulling on it.

32. Where do you think they are both going to land if gravity is going to working on both of them?
R. On the floor.

33. You think they'll both land on the floor?
R. If the candle goes out.

34. Do you think they will hit the floor at the same time?
R. If the candle goes in then the candle will be in the can when it hits.
R. I think those 2 little wires are-the candle is not going to make it-because those 2 wires are blocking it, and when the candle hits them they disconnect and that stops the electromagnet and the can falls.

35. Do you think I'll never be able to get the candle in the can?
R. No.

36. Do you think that it makes any difference that this can tilts? Does it make a difference if this can tilts?
R. It's off-balance.

37. Is that going to make any difference?
R. Yeah.
R. I think it will make a little bit of difference. Cause it won't have as much electronics, you know, the can won't have as much,

well, it won't hold it as well as if it were straight. I think.

38. Jim, shall I try it again?
R. Uh-huh.
R. I have a question. Are you trying to make the can fall and the candle go out to hit the can as it falls?

39. Well, we can't get things too synchronized today, can we?

40. So you think that the way these wires are fixed make a difference?
R. Yes.

41. If it had worked (any maybe we can get it to work) If it had worked, what would be the reason why it had worked?
R. Because you blew through the tube and that pushed the candle out.

42. What would have made the candle hit the can?
R. The candle shot over before the can ever dropped. And also, you didn't leave it at the right aim.

43. You didn't think it was aimed right?
R. It went to the left side.
R. Could you just move the cart over.

44. Which way would you like me to move it?
R. This way so the can will be at that angle.

45. Like this?
R. Yeah. (try it again)

46. Let's see- Do you think I should turn this town a little bit?
R. Yeah.
R. Yeah.
R. Yeah.

47. Well what did you see happening? Did you see the ball, I mean the candle and can hit the ground at the same time? Did you see them come anywhere near each other? Can someone describe for me, what you saw happening?
R. Well, the candle hit the rim of the cup, or the can, and it sort of fell.

48. So it was not too far off?
R. No.

49. What about did they hit the ground at the same time? Anybody notice?
R. I think the can- I think they both hit at the same time but the candle I don't know- I didn't see where it landed but it might have hit the wall.

50. You don't know? You think maybe the candle hit the wall and you couldn't tell if they hit the ground at the same time?
R. Uh-huh.

51. Shall I try it again?
R. Uh-huh.

52. Do you think it makes any difference if I blow harder or softer?
R. Seems where you blew the candle wax harder, the can seems to fall down faster.

53. If I blow this harder, then the can falls faster?
R. Yes.

54. Would that be a good deal? I mean if this is going to go swizy, don't I want the can to fall faster so they can get together?
R. Probably.

55. Does it make any difference besides that?
R..I don't know.

56. What do you think should happen, if I had this set up right?
R. Well the candle would probably go into the can and they do stay together and hit the ground together.
R. Well they might stay-but I sort of think the candle would go into the can and then go back out.

57. Oh, you think the candle would come back out?
R. The candle would hit the back of the can.

58. Does it make any difference I keep moving the can around? Can you see that it would make any difference?
R. Probably, because if you move it then you can line it up straight and the candle will have a better chance of getting into the can.

59. Everybody ready?

60. Why do you think I used a candle rather than something else?
R. Because its light.
R. Long and narrow.
R. Well it goesn't conduct electricity and it wouldn't take as long. It takes longer if you use something that would conduct electricity to disconnect the wires.
R. It fits in the tube.

Appendix D

Criteria Identified by the Investigator for Describing Poorly-phrased Questions and Ineffective Questioning Techniques as They Were Used in the Instruction

Some Criteria for Identifying Poorly-phrased Questions

1. These are narrow questions that call for yes or no responses. Some yes or no questions imply this kind of response even though the teacher was seeking more than a yes or no answer. Usually this kind of question requires asking a second question to obtain the desired response. Sometimes children will rephrase the question so as to respond in a different manner. The following are examples of yes or no questions:

> "Do any of you know what acceleration is?"
> "Is the force on the balls the same?"
> "Is there more than one force acting here?"
> "Is this the correct answer?"
> "Did it hit the ground at the same time?"
> "Could you say that they attract each other?"
> "Is it a web?"
> "Do you think this would be better?"
> "You have learned a lot about water haven't you?"
> "Do you notice anything different about this?"

2. These are also questions that elicit nonverbal responses. These are questions that result in a show of hands, nods of heads, or some other direct action that indicates affirmation or negation. These do not include questions that may cause the child to demonstrate some action that requires operating at a higher cognitive level and where he may not give a verbal response about his action. Such would be the case when a child demonstrates a skill using apparatus to solve a problem. Examples of these nonverbalized action-types of questions would include:

> How many of you saw the balls hit the floor at the same time?
> How many of you heard the balls hit the floor at the same time?
> How many of you think that way too?
> Which one fell first. (child points)
> Can everybody see?

3. Poorly-phrased questions are also narrow questions that are phrased so that they call for memory responses or recall of factual information.

Questions of this type include those that call for

a. defining a term,
b. stating a concept or principle,
c. recalling a specific term or statement,
d. describing things or events and relating direct observations-except when these are used as clarifying questions,
e. and/or naming or designating.

Therefore, these are questions that are limited in scope. Memory or recall types of questions are narrow questions. Cognitive-memory and some convergent-types of questions, used as a basis for analysis of lessons in this study, were identified with these types of questions. The following are examples of memory types of questions:

"What is gravity?"
"What is a force?"
"What scientific principle is involved here?"
"What kind of force is gravity?"
"What do you think this tin can is made of?"
"What kind of metal?"
"What is this object?"
"How many feet does a bird have?"
"How many black boards are there?"
"Which one got round?"

4. Poorly-phrased questions also include those that are poorly structured questions. This not only includes questions that are grammatically inverted but those that are only fragments of questions, such as one or two-word questions. Questions of this type, then, will have an illogical word order or may include parts of questions that are included as one question. Closely related to these types of questions are those that are statements that are intonations of questions. Also closely related to this type of question, are those that include terminology that is unfamilar to the children. Examples of poorly-phrased questions based on structure include the following:

"Here?"
"A bullet?"
"What?"
"So you think this is what?"
"Same thing would happen?"
"Think gravitational force is always identical?"
"It gets bigger?"
"All of them moved?"
" So its not too far off?"
"How is limestone?" "What is the color limestone?"
"Compared to limestone, what is the marble?" "Right?"
"Then would this form a rock then?"

5. Questions that include terminology that are unfamilar to or difficult for the children. These questions contribute to misunderstanding, quessing and confusion.

6. Very closely related to questions with difficult terminology are questions that contain too many factors to be considered simultaneously by the respondant. This also contributes to guessing or unresponsiveness.

7. Responses to poorly-phrased questions are usually predictable responses. This is most often true with yes or no and memory-type questions. Questions of this type require the children to operate merely at the lower level of cognition. For this reason, in this study, most cognitive-memory and some convergent questions are considered poorly-phrased questions.

Ineffective Questioning Techniques

For this study, the distinction was made between the function a question serves as a result of the way it is phrased and the function it serves as a result of its use in relation to other questions in a given lesson. To describe this function the investigator applied the term technique. A questioning technique, then, refers to the way in which the teacher has placed this question in sequence with the other questions, the nature of a set of questions, and the practices applied to several of the questions by the teacher in a given lesson. Therefore, the term technique refers to the way in which a given set of questions are employed by the teacher. This does not apply to the total questioning pattern of a lesson but only a segment. In terms of function the techniques do not relate as specifically to the responses for evaluation of their effectiveness as does the way in which a question is phrased. For this study, the distinction was made between effective and ineffective questioning techniques. The following are procedures that can be considered ineffective questioning techniques:

1. Asking several poorly-phrased questions during a part of a lesson
2. Asking several different questions without permitting a response
3. Asking questions and then answering them or including the answers in the questions
4. Asking questions that are irrelevant to the central problem of the lesson
5. Failing to pursue a question for complete thought processes to take place, and failing to allow adequate time for responses
6. Asking questions indiscriminately with no plan for a logical thought process to unfold during the course of the lesson, i.e. poor sequencing of questions
7. Failing to use the responses of the children in further questioning to facilitate making significant associations
8. Accepting careless or incorrect answers without further questioning or clarification.

A common practice, at least with beginning teachers, is to ask several different questions without permitting the children to respond. Although these questions may be related, they are enough different to cause rapid changes in the thought patterns resulting in confusion and misunderstanding as to the purpose of the questions. Examples taken from lessons include the following

"Well what did you see happening? Did you see the ball, I mean

> the candle and can hit the ground at the same time? Did you see them come anywhere near each other? Can someone describe for me what you saw happening?"
>
> "Do you think from what I told you previously that gravity or gravitational attraction would affect in any way the bullet that got shot or the ball that got shot over that way? If gravity, is that force going to affect it as we know that gravity here on the same one that goes straight down? Is gravity going to affect the one we shoot this way? What do you say? Yes or No?"
>
> "Susan what can you tell us about the diagrams up here? "What do you see when you look at them? Does the beak tell you anything about what he might eat?"

Typically these questions end with a narrow question and if there is a response it is also very narrow.

Closely related to this technique of asking several questions without permitting a response is the practice of asking several rapid-fire questions that compel prompt answers in order to keep attention focused on the topic at hand. The following example is taken from a lesson where this was typical of the entire lesson:

> "Does the candle go IN?"
> Yes.
> "What happens?"
> It bounces off.
> "What else do you notice?"
> It scoots away.
> "Won't it let the candle in?"
> Yes.
> "Look at the candle, is it wet?"
> Yes.
> "Does it shed water?"
> No.
> "Have you every seen insects that soak on water?"
> Yes.

Also typical for some beginning teachers is the practice of asking a question and either giving the answer in the question or answering the question without permitting responses from the children. Similar to this is the practice of asking children to repeat information exactly as it was given by the teacher in a statement that predeeded the question. Examples of asking questions that give the answer include:

> "What did I say about this, the one went straight down and the one that got shot over there?"
>
> "Look at his leg here, his foot it is in kind of a funny position. Does that tell you he might be holding on to a tree or something?"
>
> "Could you say that they attract each other?"
>
> "When you roll the big ones they are heavier."
>
> "Does that tell you anything about how they roll? Why the big ones roll and the little ones stop?"

The asking of questions that are irrelevant to the central problem of the lesson often results from an inability to deal with new information as it arises in the course of the lesson. Asking these kinds of questions detracts from making appropriate associations by the respondants. The following is an example taken from a lesson (Appendix C):

1. "Is there a difference between a force and a push?"
   "What are the two things a force is?"
   "Do you think this is an electromagnet?"
   "Is it, yes or no?"
   "What do you think this tin can is made of?"
   "What kind of metal?"

2. "What happens?"
   "Do the balls fall differently?"
   "Do they fall in a similar manner?"
   "Can anyone tell me what you saw happening?"
   "What are marbles made of?"
   "What size are the marbles?"

Closely related to this practice of asking irrelevant questions is the inability of the teacher to use responses given by the children in further questioning.

Although sequencing a set of questions for a lesson is a flexible element, it is a necessary element to provide for logical development of associations and thought patterns.

Appendix E

Transcribed Dialogue for the Video-taped Lesson Used in the Instruction to Characterize Effectively-phrased Questions and Effective Questioning Techniques

Dialogue of Lesson
Effectively Phrased Questions and Effective Techniques

Tape : Number Two
Teacher: Miss Mary Ann DeBaggio
Date: January 16, 1968
Grade: Sixth (eleven year-olds)
Demonstration: Gizzy-Falling Balls

First Part-Story of Water Buffalo Hunt (story establishes problem of two projectiles following different paths)

1. What predictions can you make, or how can we solve this problem of when did the two bullets hit the ground? What are some of your ideas?
R. I think the one that knocked off with your backfire hit the ground first because your water buffalo would be farther away.

2. What are some other ideas? Everybody agrees with what Cinder said? Well, Lisa, if you don't agree what do you think? What would you guess?
R. Did she say it would take longer for the bullet that gets shot? Well it might not because that one is just falling on its own pressure.

3. Which that are you talking about?
R. The one that you shot has more pressure.

4. So you think maybe because of that it would hit the ground first?
R. I disagree with Lisa- I think they'll both hit the ground at the same time.

5. You do, Why?
R. Well like Lisa said the one that's just dropping doesn't have any force. Well it would have some force but the gun would have even greater force so I think they would hit at the same time.

6. OK! We have 3 ideas. What are some other views that can be upheld?
R. Well I think it depends because it depends on how far up on the ladder you were and how far the buffalo was and how far up you were going to shoot. I know, but it depends on how fast the bullet is going to go and I mean how fast its going to drop to the ground. You could be shooting up higher.

7. What did I tell you about how I had the gun barrell placed?
R. On the top of the ladder.

8. It might have made a difference if I had pointed the gun up or down?
R. Yes.

9. Marcia, What are you going to say?

R. Well I agree with Cinder because if you have more force behind the bullet it's going to go farther and its going to take longer to hit the ground. Because it will be up in the air and if you miss, it will still go down sort of slowly. Whereas the one on top of the ladder will just fall straight down.

R. Well I disagree, I think the bullet will hit first because.

10. The bullet, how many bullets do we have here?

R. We have 2 don't we? One going straight down and one going out to try to shoot the water buffalo. Well, when ever you see a movie and it has guns and all and you see some guys shoot a rifle the-it doesn't take a whole long time for it to go the distance. And even though you did miss the water buffalo you'd have to shoot pretty far at an angle for it to drop after the bullet on top of the ladder hit.

11. So what are you saying?

R. I think the bullet that you shot out of the gun would hit first before the one that fell off of the ladder.

R. Well if he says the one from the gun would get through first, Well the one that fell over just had to go straight down and it doesn't have nearly as long a distance to go. So I still think they'll hit at the same time.

R. Well the one that is in the shotgun or rifle has more pressure so its going faster and its going real fast so when it hits the ground ....

12. What happens when it hits the ground?

R. I don't know. But I think the one that has more pressure is going to hit the ground first.

R. Well when we drop a bowling ball it goes faster than when you throw it, right? If you give it a little more umph then it should go at the same time. It might be, if you give it more force then I think it will hit the ground at the same time.

13. Tad, what are you going to say?

R. Well I think they're going to hit at pretty much the same time because the bullet that was shot out of the gun would have farther to go and would have more umph behind it so it would take pretty fast too and then the one fell off didn't have so far to go but it didn't have any push so.

14. If it didn't have any push, how did it go anyplace?

R. Well, it from the vibrations, I guess. I don't know.

15. What can we do right here, in room 610 University School when we're not on a safari, to figure out what's really going to happen?

R. We can use balls.

16. What are some other suggestions?

R. I don't have a suggestion but you said that they both went off at the same time, well you couldn't. Now you couldn't get them at exactly the same time.

17. Why not?

R. Ahm, I don't know, but I don't think you could.

18. You don't think we could devise some sort of apparatus, or some sort of machine that will help us do one-phst, psht and leave at the same time?

R. Not in the classroom.

R. Well if two people got up and someone said like,"Ready,go" and then one could throw and the other drop at the same time.

R. Maybe, but maybe not. They might foul it up.

R. Well how are you going to replace the shotgun?

19. What would you suggest?

R. A sling shot.

R. Well we could use dart guns, I mean those plastic-tip things.

R. I don't see how the two bullets could have left at the same time because you would have shot it. I mean it would have taken off right away and the backfire delayed it.

R. Well, if you have 2 balls or something and you drop the balls, that will be the same as dropping the bullet. But when you throw the ball that won't have at all the same amount of push as you will with the gun. And so you'd have to delay the drop of the ball or something.

20. Why would you have to delay the drop?

R. Well when you throw the ball and you shoot a gun there is going to be a difference in speed and but when you drop the ball and drop the bullet its going at about the same speed down and it just, the bullet will just go down and the ball will just go down, but then the gun fired and the ball won't be the same.

21. Are there guns that have different amount of umphs?

R. Yes

R. The slowest gun you have wouldn't have a back kick

R. Well if the gun didn't-if the gun would give umph than what could give the ball if you were going to use balls then you could just put the balls higher like at the top of the ladder- So suppose the ladder was right here then you could just use the top.

R. What would that do?

R. Well that would give the ball that was to be the gun farther to fall so that would even it out a little better.

R. Well you still have to throw the ball.

R. Lisa, I know you'll still have to throw the ball.

R. I still don't understand.

(Ask her some more questions)

R. If you use that height, it's still the same except the balls have to go farther. The balls that's going to drop is still going to be the same.

R. Well I didn't mean it that way. I meant that you-it doesn't really matter what height you throw the ball, you really can't control that but you can throw it up so you give it more time for it to come down the ball from but it does matter if you are just going to release the ball. That would even it up.

R. It doesn"t matter what height I start it at because I'm going to throw it straight out then it doesn't matter. So if its higher, it's not going to make any difference.

22. If it is higher, do both balls have to hit the ground or the floor? When we do this, do both bullets have to hit the ground,because I missed the water buffalo, will both balls finally hit the ground?

R. Well, yes but you would higher the height from which the ball falls down and keep the height the same and throw out directly and it might even things out.

(Bring out gizzy)

23. What preferences do you have for the kind of balls I should use?

R. Marbles.

R. Marbles.

24. Why don't we all get in a position where we can see?

(movement around the room)

(Boys, can we see alright if you just stand on the chairs)?

(Tell what I'm going to do-now, I'm going to hit this, this way)

25. What predictions can you make about what is going to happen to the marbles. Anybody want to make any predictions? Anybody going to want to make a bet about what's going to happen here?

R. Well probably that one marble, the first marble on this side is going to fly out that way and this one is going to drop

R. It depends on how deep the holes are. Well the, they'll both go off.

R. Well if you-are going to use the ruler and just swing it over. Well I think that ball will fly off in that direction and this ball off in this direction.

26. If you really believe that Lisley, then don't you think you better get out of the way?

R. Which way are you going to hit it?

R. Does the board spin around on the nail?

R. How much?

R. Is the nail in the middle of the yellow board?

R. Is it in the exact middle or off-center?

R. I mean is it considerably off-center?

R. Like 2 or 3 inches?

R. How much?

(can you hold the ruler?)

R. Would it matter if you have the marble a little bit farther away or that one a little bit farther out?

27. What predictions can you make about where the marbles are going to hit the floor?

R. I think they'll hit together.
R. UHM, well, I'll have to think about it.
R. Hit together.
R. I don't think they'll hit exactly the same.

28. You don"t think they'll be exactly the same?

R. I think they'll hit exactly the same. But which one is acting like the gun and which side is just going to fall?

29. What other predictions do you have about when the balls are going to hit the ground?

R. I think maybe that one will hit first.
R. Which way are you going to swing it?
R. I think they'll hit the same.

30. Kevin, do you have a prediction you want to make?

R. No.
R. I think the blue one will hit first.
R. I think that blue one might swing over here.

31. Can everybody see?

R. I don't think that one is very much like the gun.

32. It can't be exactly the same as the bullet can it, because I don"t have enought room in this room?

R. Nope.
R. I think they hit the same
R. The time before that, it bounced quite a bit and you couldn"t tell I think they hit at the same time.

33. What predictions that you made can you see have come true? Anybody make a prediction that was right? What about just the movement of the balls? Anybody make a prediction about the movement? What did you see happening? Can anyone describe for me what you saw?

R. I didn't think they hit exactly maybe-where are we supposed to judge them when they stopped bouncing or when exactly they hit the floor? Because they bounced after they hit the floor.

34. Would you like to change from marbles to something that won't bounce so much? Anybody else have an idea?

R. Ball bearings.
R. Why don't you put that on the board so we can try it later?
R. Small rocks.
R. In the beaker you brought over you have this lead ball or metal ball.
R. I think metal balls would not bounce.
R. Also in that beaker you also have, well this might not be such a good idea but you have, these wouldn't bounce at all, but you have clay balls.

R. Clay balls will help us see which one hits first.

35. Which balls is acting like the bullet that is shot out of the gun? Which ball is acting like the bullet that just fell off?

R. The one that is over there always is the gun one and this one is the one that just drops.

R. Well I think the one that is on the board that is the farthest from the nail is always going to be the one that falls straight down. And the other one is going to act like the bullet.

R. Wouldn't it make a difference if both the balls weren't the same?

36. Susan did you want to say something?

37. What it I took my chair around, Craig and hit it from the other side?

R. It shouldn't make any difference.

38. The one with the longer side is still going to act like the bullet that fell off?

39. What does anyone else think?

R. Well I think the side that you hit it on is going to be the one like the bullet from the gun because that side will have the power on it?

40. Other ideas?

(Do it again)

41. Which one acted like the gun?

R. The one on the side you pushed.

42. Which one acted like the bullet that just fell off?

R. The one on this side.

43. What do you think Craig?

R. I don't know, maybe I said it backwards.

Appendix F

Criteria Identified by the Investigator for Describing Effectively-phrased Questions and Effective Questioning Techniques as They Were Used in the Instruction

Some Criteria for Effectively-phrased Questions

1. These are questions that call for answers that are creative and imaginative and that move out in new directions.

2. These are also questions that require putting elements together in new patterns on the part of the children. They raise problems that require reflection on the part of the respondant.

3. These are questions that call for making predictions or hypotheses.

4. These are questions that call for making inferences.

5. These are questions that are more likely to lead to further experimentation, more extensive exploration of the content or greater depth investigation of an activity.

6. An effectively-phrased question is rightly related to the experience of the children being questioned. It uses terminology, makes analogies, or uses examples that are familar to the children.

7. These are questions that encourage association of ideas in the response by calling for a comparison of two previously unrelated things.

8. An effectively-phrased question will also require the exercising of some judgment and the making of discriminations.

9. An effective question is also clearly posed with a distinct word order. This effectiveness can not be judged appropriately without considering the responses.

10. Responses to effectively-phrased questions are usually unpredictable because their "open-ended" nature permits several alternative responses.

Examples of effectively-phrased questions include the following:

> "What are some thing we might do to change the materials so that we could test these ideas?"
> "If I change this condition, what can we expect to happen?"
> "If I did use this height, what things could I do to make the ball end up in the cup?"
> "What can we do right here in room 610 when we are not on a safari to figure out what is really going to happen?"
> "Before I begin this demonstration, what are some of the crucial points I should think about?"
> "How could we solve this problem of when the two bullets hit the ground?"
> "What other things could you suggest that would fit into the tube that might change the results?"
> "What if you were to start from scratch, how would you design the most accurate gun and target release?"

> "Suppose you wanted to make a model of the fastest swimming fish in the world, what parts, if any, would appear differently on the fastest fish in the world?" "How would you describe him to me?"
>
> "If we had a way to analyze the materials after they burned what changes do you think we would find?"

A clarifying question may be a narrow question, but it is a question used to clarify a response given by a child. It may also be a question that helps clarify the problem as it was presented in the original question. These may also be questions that require the child to carry out some act that helps to arrive at a response or solution to the problem. When a narrow question is used in this way, to clarify a problem, yield data directed toward the central problem, to redirect attention to the problem, extend considerations to other aspects or to qualify a response, it was considered an effectively-phrased question in this study. Clarifying questions, then, are those that are used by the teacher when he asks the child to give more information about his response. The inability on the part of the teacher to cause a child to pursue a response or the thoughts related to his response more extensively was a common problem in the fifty-five lessons analyzed by the investigator. Examples of clarifying questions can be illustrated from a part of the dialogue of a lesson used in this study (Appendix E, Questions 1-4).

A teacher using effectively-phrased questions is more likely to ask fewer questions during the course of a lesson. In terms of the desired thought processes the teacher should provide for a planned sequence for asking the questions. This will enable the teacher to keep the focus on the problem and avoid irrelevant questions. Since the effectiveness of a question cannot be judged apart from its response, the teacher must develop the habit of listening to the children to use their responses for further questioning, to enable them to make significant associations and to pursue the question more extensively.

Some Effective Questioning Techniques

No given technique, of course, is necessarily effective for all teachers but the investigator has identified practices that have apparent merit for this study. Of course, it must be recognized that the full potency of any question or questioning technique cannot be judged without considering the nature of the responses.

1. One apparently effective technique is the practice of rephrasing the same question different ways before permitting a response so as to more closely connect the intended purpose of the question with the conceptual framework for more children in the class. One distinct difference between this technique and a previously described technique that was considered ineffective, is that it usually ended with a narrow question, where this technique employs a broader question at the end of the series. The following is an example of this technique as it is employed in the lesson designed to characterize techniques and used for analysis in the instruction:

> "What predictions that you made can you see have come true? What were some of the predictions that were correct? Was there any evidence that told you that the predictions about when the two balls would hit were correct? What were some of the predictions that were correct about this movement?

2. Also apparently effective is the practice of telling a story or giving an analogy that may be hypothetical or real but one that clarifies and establishes the problem so that the questions that follow will be more meaningful. Two examples of this practice are illustrated from the transcribed dialogues of two different lessons as they were used in this

study for analysis during the period of instruction (Appendix E).

a. Example One:

> "What if I had a pea shooter and a basketball, I dropped the basketball and shot the pea through the pea shooter at exactly the same time from the same height?" "How do you think they are going to hit the ground?" "What predictions can you make about this?"

b. Example Two:

> Represents that part of the lesson that preceeded the experimenting with the apparatus used in the demonstration for the lesson.
>
> "Boys and girls I have kind of an interesting problem that I want you to think about today. Let's say that I am one of these great African hunters, except that I come well equipped on my safari. I bring a ladder along and I have my rifle and lots of extra bullets. But I am not too skilled at this yet. I see my water buffalo way in the distance. So in order to see better I climb upon the ladder and rest my gun on top of the ladder and put my extra bullets beside the gun. The water buffalo is coming closer and closer. I see him, I shoot. As I shoot the backkick on my rifle knocks a bullet off at exactly the same time as I shoot the bullet. Now, the bullet I knocked off hit the ground, I missed the water buffalo and that bullet hit the ground"
>
> "What predictions can you make, or how can we solve this problem of when did the two bullets hit the ground?" "What are some of your ideas?"

3. A practice of holding to a question long enough for thought processes to be completed is also considered desirable. Such a practice often requires supporting an effectively-phrased question with several clarifying questions (Appendix E, questions 1-14).

4. The practice of using a questioning pattern that calls for the use of only a few questions that are effectively-phrased questions can also be considered a desirable technique. One effectively-phrased question can accomplish more than several poorly-phrased questions. Therefore, a teacher

using effectively-phrased questions is more likely to ask fewer questions during the course of a lesson.

5. In terms of the desired thought processes the teacher should provide for a planned sequence for asking the questions. This will enable the teacher to keep the focus on the problem and avoid irrelevant questions. Since the effectiveness of a question cannot be judged apart from its response, the teacher must develop the habit of listening to the children to use their responses for further questioning.

Appendix G

System of Four Categories and Represenative Questions Used in the Instruction for the Purpose of Classifying Questions

A System for Categorizing Questions

Cognitive-Memory Questions

This is the lowest level of questioning. These are usually narrow questions. As narrow questions, they elicit recall or rote memory responses. Questions that call for yes or no responses are typical of this level of questioning. As questions that call for recall of facts, they require defining or describing by the respondees. This would include questions that call for predictable responses. These questions may also call for naming. This would be the case when the teacher asks the child to give a term. Examples of cognitive-memory questions include the following:

"Did the balls hit at the same time?"
"What scientific principle is involved here?"
"What is force?"
"Is there a difference between force and push?"
"What do you observe when this happens?"
"Is it a web?"
"How many of you saw the balls hit the floor at the same time?"
"What kind of metal?"

Convergent Questions

These are questions that call for predictable responses that are broader than the cognitive-memory types. This kind of question asks the respondee to integrate ideas and relate these ideas in explanations using his own words. Therefore, questions at this level call for responses that demand a comprehension of concepts and their interrelationships. The respondant must know certain facts if he is to understand the concepts and describe their relationship. There is often one best answer to a question in this category. However, these questions require more stating or explaining than that required from cognitive questions. Examples of these kinds of questions include the following:

> "Why do the balls hit at the same time?"
> "What does the spring do?"
> "How do you explain the word acceleration in your own words?"
> "Explain briefly in your own words what is meant by the word hypothesis."
> "In what way is this picture like that one?"
> "How does gravity affect the balls?"

Divergent Questions

This is the third and probably most important level of questioning. These questions encourage divergent or broad responses, that is, responses that are creative and imaginative, They require the respondants to organize elements into new patterns that were not previously recognized clearly. These are questions that permit originality by the child as evidenced in the hypotheses he makes and in the way he uses his knowledge to solve new problems. Divergent questions are those that permit predicting, hypothesizing, and/or inferring. Questions that are identified as "What if.....?" questions are common in this category. These are questions that require solving a lifelike or hypothetical problem by identification of the issue or recognition of the problem and the selection and use of appropriate generalizations. These questions call for unpredictable responses rather than the "one right answer." Examples of these kinds of questions include the following:

> "What predictions can you make about what is going to happen to the marbles?"
> "What do you think would happen if the balls were of a different mass?"
> "If the fish did not have all these body parts, what sort of things might occur when he wanted to move about the fish bowl?"
> "Suppose you were trying to convince someone that air is real; how would you do it?"
> "Suppose you wanted to make a model of the fastest swimming fish in the world, what parts, if any, would appear differently on the fastest fish in the world?" "How would you describe him to me?"

"If I did use this height, what things could I do to make the ball end up in the cup?"

Evaluative Questions

The fourth level of questioning is the evaluative type. These questions deal with matters of judgment, value, and choice. They may be either broad or narrow. They cause the respondee to organize his knowledge, formulate an opinion and thereby take a self-directed position. In order to make judgments the respondant has to use evidence. To use evidence he must use criteria. He makes judgment of good or bad, right or wrong according to standards that either he designates or to standards someone else has established. This is the highest level of questioning and involves, all three of the other levels. The following are some examples of these kinds of questions:

"What makes this picture better than that one?"
"Are the conclusions that John made about the experiment accurate? Why?"
"Why do you say that this is the best order for arranging these objects?"

Appendix H

Instrument Utilized for the Post-testing and the Related Transcribed Dialogue

This is a dialogue of a student teacher working with a group of third grade children. She presents the children with the following materials:

a large bowl with water
a soft drink bottle and stopper and filled with water
food coloring
paper cups
medicine dropper
modeling clay
alka-seltzer tablets

The problem of this activity is to get the water out of the soft drink bottle without turning it over and pouring it out. In this activity the teacher wants the children to make accurate observations and to explain their observations by giving reasons for the events they observe. Therefore, she has set the following as her objective for this lesson:

> Given the materials described for this activity the children will be able to make accurate observations and verbally state inferences to explain the movement of liquid out of an inverted container when air moves into the container. They shall also be able to suggest observations which can be used to test these inferences and lead to further experimentation.

The sequence of this activity is something like this: present them with the problem, suggest and try solutions, make observations, make inferences about observations and test out inferences made. For example, one very simple way of testing the inference that the water flows out of the bottle when the air flows in is to measure the change in the water level by marking the bowl.

1. Construct a question you would use to initiate this lesson that would more effectively present the central problem of the activity. (If you would change the conditions of the activity, describe what you would do)

2. Questions one through twenty-four involve an attempt to solve this problem and to make observations on the results of trying the children's solutions. What questions would you ask to make this section of the lesson more interesting to the children? Suppose you want the children to make better observations, to describe more accurately what they observe. You may also use questions that would cause the children to make predictions, hypothesize about certain changes and/or suggest changes they could introduce into the activity. Put your questions in the order in which you would ask them.

3. Questions twenty-five through forty-seven involve testing out the explanations the children have made. How would you reconstruct the questioning for this part of the lesson? Assume that you want to encourage ideas that would lead to further experimentation and/or exploration of related ideas. List your questions in sequence.

Dialogue of a Science Lesson

Grade and Age: Third (eight year-olds)
Teacher: A student teacher
"Some Experiments with Water"

1. Now, see this bottle?
   R. Yes.

2. What do you think it's for?
   R. Water.
   R. H_2O.

3. I want to know how to get the air into this bottle?
   R. Just lift it up above the surface.
   R. Lift it up.

4. Lift it up?
   R. Yeah, just above the surface.
   R. You see its like a vacuum now because there is no air in it.

5. If I lift it up, where do you think the air would go?
R. Into the bottle.
R. Up into here then all the water will come out.

6. Where about in the bottle do you think it will go?
R. All over.
R. All over as soon as the water gets out.

7. Shall I lift it straight up or tilt it?
R. Straight up.
(teacher trys it)

8. What happens when I put the bottle back in the water again?
R. It stops again.

9. It stops and no air goes into the bottle?
R. M'M.

10. What if I tilt it?
R. The water still comes out.
R. It goes faster.

11. Now, what if said, ------we'll fill the bottle back up with water again, What if I said, ah, that we couldn't take the bottle out of the water line in the bowl? (no response)
R. Hey.
R. M'mm.

12. Then what could happen. Then what could happen? You were right when we lifted the water up out of the bowl the water flowed out and air got into the bottle, right?
R. Yeah.
R. M'mm.

13. But now lets say I have it in here like this and I can't lift the bottle above the water level in the bowl?
R. Take all the water out with the cup.

14. How do I get the cups in there to take the water out?
R. OH!
R. You'll need another one.
R. I know how you can do it.
R. I know a different one.

15. Well, where are you going to put the water in the bowl?
R. In the cup
R. In a bigger cup.
R. I know how you can do it.
R. Put the straw under the top of the bottle and then just blow and if the air goes up its a awful hard thing.

16. Oh, Ron you want to step over here and try that?
R. You better have a lot of straws.
(child uses straw to blow air into bottle)
R. Why do you think it happened?
R. Well air travels through the straw. Thats why.
R. Well, when the air goes up, you know, it just pushes the water out.
R. Hot air goes up.
R. Hot air always goes up and you can't stop it and your breathe is usually hot.

17. Why do you think air is at the top of the bottle instead of at the bottom?
R. Because its turned down.
R. Well the air is lighter than the water.

18. Can you think of another way you can do it?
R. M'mmm we might be able ------
R. I douht if it will work but we'll try it-----by dipping the water out.

19. But if I dip the water out of the bowl then I get less than the water level than I can't do it because the bottle is not below the water level. Isn't that right?
R. No.
R. I know but it would get air in the bottle-water in the bottle.

20. OK,you're going to sip it out of the bottle
R. No, it will run as we need more water
(teacher trys it) (children try it) (children try it)

21. OK,now let me pose this problem for you Tim. After you get all the water out of this bowl, right, the bottom of this won't be under water anymore will it?
R. No.
R. And then air will come in.
R. Thats what we're trying to do.

22. But I just said you can't put the bottle out of the water in the bowl?

23. What happens to the water in the bottle? It just disappears?
R. No.
R. It went into the bowl.
R. In the bowl.

24. In the bowl?
R. None of it stayed in the bottle because there wasn't any in there.
R. You see you ---------

25. How do you think we could prove this?
R. Well we could put food coloring in and watch it.

26. You want to try that?
    R. Yes.
    R. Can I pour it in.
(put food coloring in-some confusion)
(children taste it)

27. Did it taste like water?
    R. It did.
    R. Food coloring that doesn't hurt you
(puts bootle in some comes out)

28. Why do you think a little comes out?
    R. Way on the bottom it would come out.

29. If you blow it easy, what do you think happens? (no response)
(try it)

30. See something down there? (no response)

31. Does it make any difference if -------
Does it make any difference if you have the straw right under the bottle or you don't have it under the bottle?
    R. Well, lets try it.
    R. Lets try it.
    R. Lets try.

32. Does any air come out?
    R. No.
    R. Some comes out.

33. What could you say that meant? With the straws? Did it make any difference if you placed the straw in?
    R. No.

34. What did you prove?
    R. We proved if you blow there you don't have to blow about there but you could blow there and still have it work.

35. Did it work like that?
    R. No.
    R. No.
    R. It has to go over like that or straight up, because if you keep blowing right there it goes straight up in the bottle.
    R. Lets try it again
    R. It's a problem

36. So you say that it does make a difference where you place the straw because if you don't have the straw close enough to the bottle not enough air will go into the bottle.
    R. Yeah
    R. Well lets try it again and watch carefully
    R. How are we going to try it there is no water.

37. Did everybody see how it came out?
    R. We can watch in the bottle.
    R. We can watch the bottle.
    R. Thats it now put your finger over it and ....

38. See it?
    R. Yeah.

39. It does make a difference?
    R. Yeah.

40. Everybody was right, huh?

41. Now what if we use one of these?
    R. It might work.
    R. It will still work.
    R. I do it in the bath tub all the time.
    R. Hold, it lets go back.

42. So what could you say about this?
(no response)
    R. Put it right over an oxygen bottle.
    R. Its kind of like a pump.

43. Like a pump?
    R. Yeah, like here's the air and it just goes rumph and theres no room for the water so it just goes rooh (sound and motion).

44. I see, so it pushes the water, the air out? Right?
    R. Yeah.

45. So, what could you say about the air?
    R. It can replace things.

46. If it can replace things, what else could you say about the air? It took up a certain amount of ________room.
    R. Room.
    R. Of the water.
    R. Colored water.

47. So there you could say air occupies space, right?
    R. I guess.
(tells that air displaced the water

48. Does anyone know what this plate is for?
    R. Stick the empty bottle down in the water and lets try it then.
    R. Lets see if it makes the water go up in the bottle.

49. You'd stick the bottle in this way right?
    R. Yes.
(trys blowing water up into bottle)

Appendix I

Instrument Used for Student Opinion Questionnaire To Assess the Effectiveness of the Instructional Program

Student Assessment of Instruction on Questioning

Recently you participated in an exploratory study designed to define a method of instruction that would be effective for instructing prospective elementary teachers in questioning. Recall that the study of questioning was presented and dealt with in two aspects: phrasing and technique. Recall also that the instruction provided situations for lessons with children in grades one through six. Through the use of audio-and video-tapes you were asked to evaluate and reconstruct questions and questioning patterns. In this instruction on questioning several approaches were dealt with to provide some assessment of their effectiveness. At this time your reactions and evaluations will be important data for describing this instructional program and its effectiveness. Please react to the following questions to the best of your ability and in an honest manner.

1. What evidence can you give that you gained from the sessions on questioning?

Respond to each item below by circling the number from one to five that most accurately represents the degree of favorable change for you.

	Low to High
a. I am more conscious of alternative responses to certain questions than I was before.	1 2 3 4 5
b. I am able to give more careful thought to questions when planning lessons.	1 2 3 4 5
c. I am more critical of questioning patterns used in textbooks or other printed materials.	1 2 3 4 5
d. I am more able to identify certain types of questions and questioning techniques in lessons conducted by others.	1 2 3 4 5
e. I am able to predict more effectively the result of asking certain types of questions.	1 2 3 4 5

	Low to High
f. I am more able to write divergent questions	1 2 3 4 5
g. I am more able to use divergent questions in lessons.	1 2 3 4 5
h. I am more able to judge the effectiveness of a question on the basis of the responses obtained.	1 2 3 4 5
i. I can more effectively rephrase poorly-phrased questions.	1 2 3 4 5
j. I have become more knowledgeable of the differences between divergent, convergent, dognitive-memory, and evaluative questions.	1 2 3 4 5
k. The instruction on questioning made me more conscious of the way children at different age levels think and act.	1 2 3 4 5
l. The instruction on questioning made me feel uneasy about teaching.	1 2 3 4 5
m. I am so conscious of questions that I am not able to maintain the thought pattern.	1 2 3 4 5
n. I am so aware of the questioning procedures that I am not able to effectively consider other aspects of a lesson.	1 2 3 4 5

2. What phases of the instruction did you find most beneficial? In response to this question rank the following in order from the MOST BENEFICIAL TO THE LEAST BENEFICIAL by numbering the items from one through eight (1-8).

   a. Analysis of video-taped lessons of teachers.

   b. Analysis of audio-taped lessons.

   c. Lessons analyzed through the use of a combination of audio and video tapes.

   d. Brainstorming questions from single concept films.

   e. Group planning and evaluating of a questioning pattern conducted in a fifth grade classroom.

f. An analysis and comparison of a questioning pattern designed by the methods students with questions raised by fifth grade children.

g. The written assignments that required evaluating and reconstructing questions and questioning patterns.

h. The use of the category system (divergent, cognitive -memory, convergent, and evaluative) to identify and classify sample questions according to these categories and its application to video-taped lessons.

3. Which aspects of the instruction on questioning do you feel should be changed?

In each of the following, IF YOUR RESPONSE IS YES, provide a brief explanation of why you think it should be changed.

	yes	no	undecided
a. The length of time devoted to the instructional program.			
b. The sequence of the approaches used in the instruction.			
c. The use of video-taped demonstrations.			
d. The practice of showing video-tapes twice.			
e. The written work requiring evaluation and reconstruction of questions.			
f. The use of the four categories as a means for identifying questions.			

a. Response:

b. Response:

c. Response:

d. Response:

e. Response:

f. Response:

TABLE 16. OPINION QUESTIONNAIRE FOR STUDENT ASSESSMENT OF THE INSTRUCTIONAL PROGRAM ON QUESTIONING PART I

		Low		Responses		High	
Item	0	1	2	3	4	5	T
A	0	0	1	6	20	10	37
B	0	0	0	3	16	18	37
C	0	0	0	13	10	14	37
D	1	1	1	3	18	13	37
E	0	1	1	2	19	14	37
F	0	0	1	6	20	10	37
G	0	0	1	8	17	11	37
H	0	0	1	6	18	12	37
I	0	0	1	9	19	8	37
J	0	1	0	5	18	13	37
K	0	2	11	10	10	4	37
Total	1	5	18	71	185	127	407
Per cent	0.24	1.22	4.42	17.44	45.45	31.20	
L	0	10	10	14	1	2	37
M	1	5	6	11	12	2	37
N	1	10	5	7	12	2	37
Total	2	25	21	32	25	6	111
Per cent	.90	22.52	18.91	28.82	22.52	5.40	

TABLE 17. OPINION QUESTIONNAIRE FOR STUDENT ASSESSMENT OF THE INSTRUCTIONAL PROGRAM ON QUESTIONING PART II

	Ranking for Phases of Instruction							
Item	1	2	3	4	5	6	7	8
A	9	9	2	4	6	2	3	2
B	1	5	9	8	4	4	2	4
C	9	7	8	7	5	0	1	0
D	2	5	4	4	3	9	4	6
E	5	3	2	6	3	6	5	7
F	2	3	6	4	4	5	7	6
G	2	3	4	5	4	5	8	7
H	8	3	7	3	6	3	3	4

TABLE 18. OPINION QUESTIONNAIRE FOR STUDENT ASSESSMENT OF THE INSTRUCTIONAL PROGRAM ON QUESTIONING PART III

Suggested Changes in Instructional Program							
Item	Yes	Per Cent	No	Per Cent	Un-decided	Per Cent	Total
A	22	59.45	10	27.02	5	13.51	37
B	1	2.70	30	81.08	6	16.21	37
C	7	18.91	27	72.97	3	8.10	37
D	5	13.51	27	72.97	5	13.51	37
E	15	40.54	18	48.64	4	10.81	37
F	5	11.51	30	81.08	2	5.40	37
Total	54	24.32	142	63.95	25	11.26	222

Appendix J

Sample Questions and Instructions to Judges Used for Purpose of Categorizing the Questions Written by the Subjects in the Pre-test and Post-test and to Establish Interjudge Reliability

Evaluation of Data from Study on Questioning-Instructions for Judges' Evaluation of Pre-test and Post-test Responses

The two-hundred and twelve items you are about to evaluate represent a random sample of the questions written during the pre-test and post-test by the subjects involved in the study on questioning. These questions were written in response to the following criteria:

> You have listened to the actual lesson, and you have examined the dialogue of the questions and responses, as well as doing the activity yourself. What questions would you ask for the part of the lesson described by question number ___________ to question number __________ in order to make it more interesting to the children? If possible, include questions that do the following:
>
> a. cause the children to make more complete observations,
> b. cause the children to make more accurate descriptions and to state relationships,
> c. cause the children to make inferences about their observations (explanation),
> d. and/or cause the children to suggest ways of extending this activity to lead to further experimentation by:
>
> (1) making predictions,
> (2) hypothesizing about certain changes,
> (3) and/or suggesting changes they could introduce into the activity.

Please place your questions in the order in which you would ask them. Please read each question carefully, weigh its intent, and make your decision on the category to which it best fits. As you do so, you may want to refer to the category system to consider the criteria and examples given for each category. The questions are arranged in the sequence in which they were written. They have been presented as sets to maintain the context in which they were written. Please note that some questions are dual questions. In those items where two or more questions are given together, it was assumed that they would have been asked this way since they were written in this manner. You are advised to evaluate each of these questions separately. Therefore, it is possible to have more than one symbol for a given item. On items of this type, be sure that your symbols are in order so as to correctly identify the questions for which they are intended.

Use the following symbols for each category:

C-M	cognitive-memory
C	Convergent
D	Divergent
E	Evaluative

Please place the appropriate symbols(s) in the blank beside the question number. It may be necessary for you to read some assumptions into questions. If this causes serious doubt about any item, place a question mark beside the symbol you have used.

Some Miscelleanous Questions from the Sample Submitted to the Judges for Evaluation

Pre-Test

1. ______ How does the water act when we put it on newspaper? Does it jump up and down?
2. ______ Does it sink in fast or very slowly?
3. ______ When it sinks in does the water spread very far?
4. ______ What makes the water decide how big a wet spot it makes on the newspaper?
5. ______ Does the shape of the stain on the newspaper change with different size drops?
6. ______ When we put two little drops very close together, what can we see happen?

7. ______ Does the same thing happen with two big drops or one big drop and a little drop?

8. ______ Do the drops on the newspaper move at all?

9. ______ Do the drops on the waxpaper move at all?

10.______ How can we make them move?

11.______ Maybe we have to push them or would they move if we blew on them?

Post-Test

1. ______ Where do you think the water will go and what causes it to do this?

2. ______ What else can we do to cause the water to come out of the bottle?

3. ______ What else could we do to prove this?

4. ______What predictions can you make about what will happen?

5. ______ Now I want to get the water out of the bottle. Only I must keep the mouth of the bottle under the water? What are some of your ideas about how we can get this water out of the bottle (test the ideas)

6. ______ What do you notice about the movement of the air (blowing with straws) bubbles? Why do you think this happens?

7. ______ What might be some other substances that we could put in the bottle in place of the water so that the air would not go to the top of the bottle?

8. ______ In what way might the air bubbles be affected by the different substances?

Appendix K

Summary of an Interview with the Teacher Who Prepared the Video-tapes Used in the Instruction

Summary of an Interview with the Teacher Who Prepared The Video-tapes Used in the Instruction

It is not directly evident from this study what types of changes the methods of instruction will have on the subjects as they find themselves in the teaching role. However, the comments of the classroom teacher used in the video-taped lessons may be a small indication of the results which may occur in the classroom. For this reason, an interview was held with the teacher in order to identify the changes she noticed with the children and herself as a result of using the two questioning patterns. The following is a summary of that interview.

In order for the lessons to be prepared by the teacher to be used for the instruction, it was necessary for the teacher to undergo some conditioning for the instruction in order to familiarize her with the types of questioning patterns to be employed in the lesson. This initially caused the teacher to do much self-evaluation of the questions which she asked during the course of a teaching day. As result of her awareness of the number of poor questions she asked, it became obvious to the teacher that she would have to prepare thoroughly before attempting to video-tape lessons which employed effectively-phrased questions.

The teacher felt that in order to teach the lessons most effectively, whether poor or good lessons, it was necessary to carefully plan the questions with the investigator.After the initial planning sessions, trial-teaching periods of these lessons were audio-taped and analyzed for the effectiveness of the questioning patterns. It became most apparent to the teacher at this time that there were several factors which influenced the effectiveness or non-effectiveness of the lessons and, thus, alterations were made to emphasize these factors most clearly.

For the teacher herself the following aspects of the lesson became an on-the-spot criteria for effective questioning:

1. pupil verbal responses- the quality and quantity of responses that were given by the children
2. pupil affective responses-facial expressions, involvement, contemplative silence, and the "I'm-with-you attitude"
3. ability to utilize student ideas in the ensuing questions of the lesson
4. ability of the teacher to rephrase a question which was unclear to the students in a divergent manner which allowed for a greater number of responses
5. ability of the teacher to utilize certain narrow questions in order to clarify and refine student thinking.
6. ability to utilize a logical sequence in the questioning pattern that aids students to understand the problem, make accurate analysis of the problem, identify relevant variables, and synthesize the data in order to hypothesize, predict, or explain
7. ability to foster an attitude of freedom of expression and worthiness of each child's response.

In order to identify those aspects of a lesson which utilizes a poor questioning pattern, the following is a description of the reactions of the students and the teacher of the lesson in which such a pattern was used.

The teacher felt ill-at-ease presenting a lesson in which she had become aware of the detrimental effects to the learning situation.

Although the teacher and investigator jointly planned the lesson in order to ensure that there were many narrow questions utilized, irrelevant questions asked, no logical sequence followed, and ineffective questioning techniques used, the teacher felt little pressure to change many of her normal classroom procedures. For this reason, the teacher's main concern was with the effects of stifling the children's receptivity and lack of direction in acquiring basic concepts.

During the course of the lesson it was obvious that the children were confused and uninterested by the blank expression most of them wore throughout the period. There was a great deal of wiggling and fidgeting noted by the teacher. There was evidence of stifling the children as seen by initial attempts of many children to respond to a question to fewer volunteers. Immediately following the lesson, several children came to the teacher with a deluge of questions such as, "What is the 'whizzbang' supposed to do?"; "How did you make the 'whizzbang?"; "Can *we* try it now?" When the materials were reassembled the following day, in order to reteach the lesson, one student asked, "What is the problem, I mean, what are we trying to do?" These questions were also indications to the teacher that the children had been unable to identify the problem, to become familiar with the operation of the apparatus, and to to personally involved with the demonstration. Another aspect of their inability to grapple with the problem was the children's desire to pursue all the questions, even the irrelevant questions in order to fill in the gaps and confusion that the ineffective questioning had caused.

However, it was obvious to the teacher that many of the opposite reactions occurred during the lesson which utilized effectively-phrased questions and effective questioning techniques. The quality of the responses given by the children to the effectively-phrased questions gave evidence that the problem was clear. The children's responses showed evidence of their ability to reason through a problem when directed by questioning techniques that enhanced this aspect of the child's development. There was a lack of external confusion on the part of the children. Although the children seemed to have internal chaos until they had exhausted all of their ideas, this was a liveable frustration since it was caused internally and not by a lack of teacher-directedness. Resulting from the effectively-phrased question lesson, the children and teacher became involved in a week-long investigation of the "gizzy" and the manipulations of variables which the student's had requested.

Since the teacher of the lessons was most concerned about the communication that is established between teacher and pupils, she wished to have the children view the video-tapes and disucss the questions that were asked in the course of the lessons. It was revealing to the teacher that sixth grade children were so aware of both the atmosphere in the classroom and also the nature of the questions that were asked. Through questioning, the children were able to identify various categories of questions which had been utilized in the lessons. These categories were very similar to those categories which the investigator had devised for identifying questions.

Although the teacher involved in the lessons was not overly concerned with the time/content problem, she responded to the question involving this problem which concerns many teachers. She definitely realized that lessons involving effective questioning techniques and student involvement consume much more class time than an expository, read-the-textbook method. However, she feels that the benefits involved in this approach far outweigh the controversy concerning fact accumulation. She indicated that student involvement, which necessitates allowing the students to manipulate materials in order to test their own ideas, allowing digression from the planned sequence in order to investigate their ideas, and allowing time for children to thoroughly think through the problem, is more important than demanding students to regergitate information. She also felt that content which was covered in this manner was more meaningful, more appropriate, and more readily retained. Therefore, it is obvious that content is covered in more depth while involving the processes of science than in a lecture-method approach.

In summary, the teacher felt that there were three basic results that were accomplished in her own awareness of the need for more effective questioning in the classroom. First, the clarity that was necessary in order to phrase questions effectively caused greater communication between the students and the teacher. Since she feels that this is necessary for the effectiveness of a learning situation she feels that this is primary. Secondly, the type of questioning which utilizes a greater number of divergent questions allows the students the freedom to think on their own and thus come one step closer to being independent inquirers. Thirdly, the teacher found that there was a need to rethink the method of written evaluation that she used in science and thus was able to devise test items that were more effectively-phrased and allowed the students to continue to be problem-solvers even in a written test form.

Appendix L

Questions Raised by the Fifth Grade Children for the Demonstration Used in the First and Last Days of Instruction

Questions Raised by Children about the Falling Ball Apparatus

1. What if we had a different ball?
2. What would it do if we had a lighter ball?
3. What if we had a different shape ball?
4. What would happen if we put the cup in different places?
5. What if we had a smaller ball?
6. Would it have the same affect if we had a different material?
7. What would happen if you had two balls?
8. How did the ball fall into the cup?
9. What if we had a smaller cup?
10. Will all the things that go in the hole in the wood go into the cup?
11. Why does the ball go into the cup?
12. What would happen if we had a bigger domahicky?
13. What if you had the bottom board slanted and not level?
14. What if the top board was proped up two feet?
15. What would happen if we used a wood ball?
16. What if the cup was not on the same spot?
17. Why not use a wider board?
18. Why does the ball fall in the cup when it is higher and lower?
19. Can you put it a lot higher?
20. What does it prove?
21. At what angle is the two sticks?
22. What is the ball made of?

Appendix M

Frequency and Per Cent of Questions Written by All Subjects on the Pre-test and Post-test

TABLE 19. INVESTIGATOR'S JUDGMENT OF THE TYPES OF QUESTIONS WRITTEN BY EACH SUBJECT ON THE PRE-TEST

	Frequency and Per Cent						
Subject	Total Number Questions	Cognitive-Memory	Per Cent	Convergent	Per Cent	Divergent	Per Cent
1	8	6	75	1	13	1	12
2	3	0	0	1	33	2	67
3	8	4	50	3	37	1	13
4	4	1	25	2	50	1	25
5	5	4	80	0	0	1	20
6	7	4	57	2	29	1	14
7	9	4	44	2	22	3	34
8	3	2	67	1	33	0	0
9	7	6	86	1	14	0	0
10	5	5	100	0	0	0	0
11	7	3	43	4	57	0	0
12	8	5	63	3	37	0	0
13							
14	12	8	67	4	33	0	0
15	6	4	67	2	33	0	0
16	7	5	71	1	15	1	14
17	12	11	92	0	0	1	8
18	7	6	86	1	14	0	0
19	6	4	67	1	16	1	17
20	5	4	80	1	20	0	0
21	3	2	67	1	33	0	0
22	6	6	100	0	0	0	0
23	6	3	50	3	50	0	0
24	9	5	56	1	11	3	23
25	7	4	57	1	14	2	29
26	4	1	25	2	50	1	25
27							
28	5	2	40	0	0	3	60
29	8	3	38	4	50	1	12
30	3	2	67	1	33	0	0
31	16	9	56	2	13	5	31
32	9	6	67	2	22	1	11
33	9	8	89	0	0	1	11
34	5	5	100	0	0	0	0
35	9	6	67	1	11	2	22
36	2	0	0	1	50	1	50
37	14	10	71	2	14	2	15
38	3	3	100	0	0	0	0
Totals	247	161	65.18	51	20.65	35	14.17

TABLE 20. INVESTIGATOR'S JUDGMENT OF THE TYPES OF QUESTIONS WRITTEN BY EACH SUBJECT ON THE POST-TEST

Subject	Total Number Questions	Cognitive-Memory	Per Cent	Convergent	Per Cent	Divergent	Per Cent
1	8	1	12	1	13	6	75
2	3	2	67	0	0	1	33
3	6	1	17	2	33	3	50
4	5	1	20	0	0	4	80
5	8	3	37	1	13	4	50
6	4	0	0	1	25	3	75
7	13	5	38	5	39	3	24
8	20	1	10	4	40	5	50
9	9	5	56	1	11	3	33
10	6	1	17	3	50	2	33
11	4	0	0	0	0	4	100
12	8	4	50	1	13	3	37
13							
14	8	0	0	2	25	6	75
15	10	1	10	2	20	7	70
16	4	1	25	1	25	2	50
17	9	3	33	1	11	5	56
18	7	2	28	2	29	3	43
19	8	4	50	1	13	3	37
20	7	4	58	1	14	2	28
21	8	3	38	2	25	3	37
22	24	5	21	7	29	12	50
23	8	2	25	2	25	4	50
24	12	3	25	6	50	3	25
25	13	4	31	1	7	8	62
26	11	3	27	3	27	5	46
27							
28	15	3	20	6	40	6	40
29	20	4	20	9	45	8	35
30	13	5	38	3	24	5	38
31	11	7	64	0	0	4	36
32	15	7	47	2	13	6	40
33	22	16	72	0	0	6	28
34	8	3	37	3	38	2	25
35	15	9	60	2	13	4	27
36	7	5	71	1	14	1	15
37	18	8	44	0	0	10	56
38	16	5	31	2	13	9	56
Totals	376	131	34.70	78	20.80	167	44.50

Vita

Roger T. Cunningham was born in Rockford, Illinois, September 12, 1935. He attended Winnebago Public Schools and upon graduation from Winnebago High School, he enrolled at Illinois State University, Normal, Illinois.

Mr. Cunningham was granted the B.S. degree in Education in 1957 from Illinois State University, with majors in Health and Physical Education, and Social Studies. The M.A.T. degree in Science Education was earned in 1962 from Michigan State University. While working toward the M.A.T. degree Mr. Cunningham also attended the University of Wyoming, Northern Illinois University and Macalester College.

Mr. Cunningham began his teaching experience in 1957 at Winnebago Junior-Senior High school where he taught junior high school general science. He remained in this position until 1961, when he took a leave to do graduate study. Upon completion of M.A.T. degree he was employed by Fairview School District Number 72, Skokie, Illinois, from 1962 to 1966. His position was that of Science Consultant for kindergarten through eighth grade. In addition, teaching responsibilities involved Mr. Cunningham in teaching science to children of all ages within this elementary school. In this position Mr. Cunningham developed a non graded elementary science program, served as chairman for the Niles Township Curriculum Committee which included nine elementary school districts and one large high school district in a North suburb of Chicago. In this position, Mr. Cunningham also served as a consultant for the State of Illinois, conducting in-service programs for other school districts. From this position, Mr. Cunningham received a faculty appointment at Indiana University as a Lecturer in Education for the year 1965 until the present.

While at Indiana University, Mr. Cunningham taught elementary school science methods, both graduate and under-graduate and served as a member of a team of faculty members teaching methods in an experimental program of teacher preparation called INSITE (Instructional System in Teacher Education). Mr. Cunningham also served as a consultant for the Columbus Indiana School Corporation and the Goshen County Schools. Mr. Cunningham pursued further graduate work leading to a doctor of education degree at Indiana University.

Mr. Cunningham has authored a publication "Implementing Non graded Advancement with Laboratory Activities as a Vehicle: An experiment in Elementary School Science", contained in School Science and Mathematics, February, 1965.